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ROYAL AND DISTRICT AGRICULTURAL SOCIETIES' 50-ACRE CROP COMPETITIONS, 1938.

I. THOMAS,
Superintendent of Wheat Farming.

During the past eighteen years, the Royal Agricultural Society has promoted crop competitions amongst district Agricultural Societies in the wheat belt. On account of the great variation in soil and climatic conditions the wheat belt has been divided into eight zones in such a manner that districts having similar interests and climatic conditions are grouped together. In this way farmers compete with each other more equitably. The zones referred to are shown in the accompanying map.

Entry for these competitions is made through the affiliated district Agricultural Societies. The first and second prize-winners of these district competitions, provided these are conducted under the conditions laid down by the Royal Agricultural Society, automatically become eligible to compete for the prizes offered by the Royal Agricultural Society. Some Societies, however, make no provision for crop competitions, and in order that farmers in these districts may not be debarred from participating, the Royal Agricultural Society permits them to enter for the competition direct with them.

In each zone a championship prize of £10 and a second prize of £2 10s. are awarded. In addition to these prizes, the Royal Agricultural Society offers a special prize of £5 5s. to the competitor, in any zone, who obtains the highest calculated bushel yield per acre.

The conditions of the competitions require that the crop shall be grown on fallowed land; shall be not less than 50 acres in a compact and unbroken plot of one variety; and shall be judged under the following scale of points:—

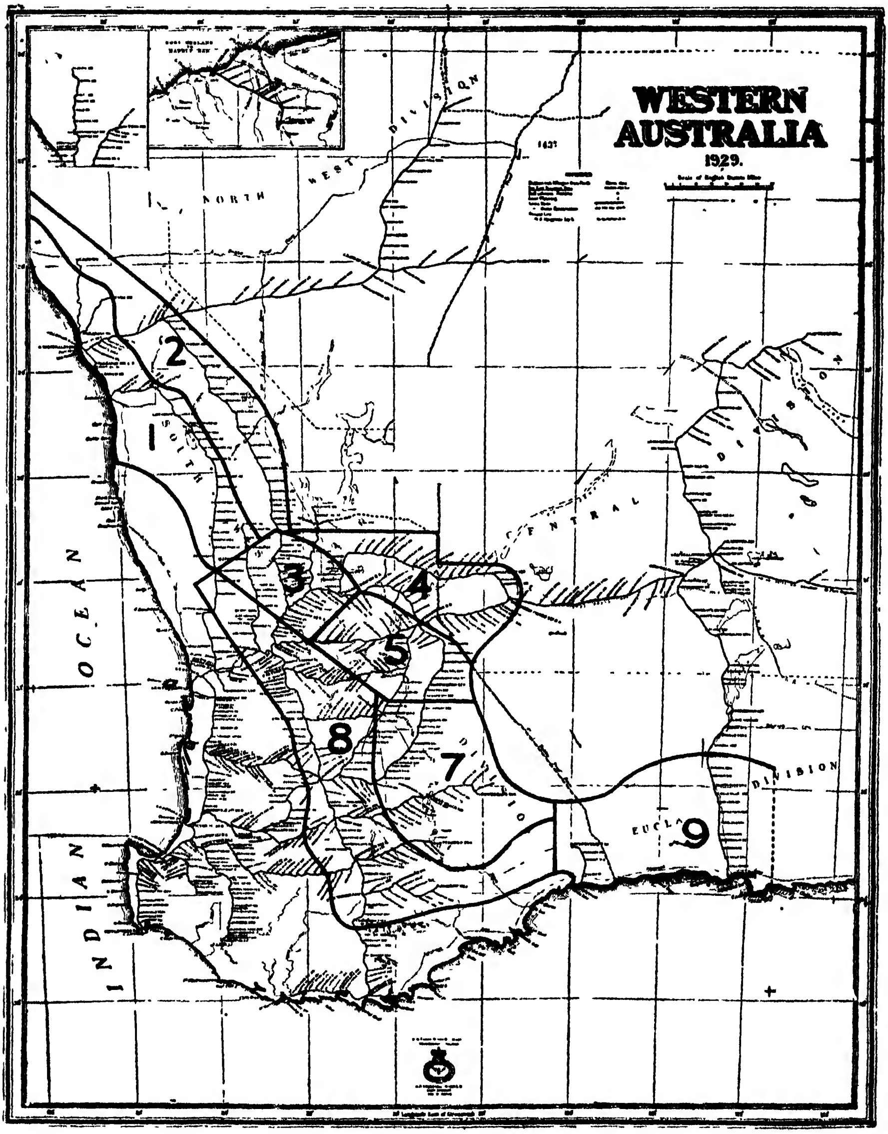
Yield	50 points
Freedom from Weeds	10 „
Freedom from Disease	10 „
Freedom from Admixture	15 „
Evenness of Growth	15 „
Total	100 points

The practice is to allot one point for each bushel of calculated yield per acre, which is determined by taking quadrat samples systematically throughout the crop, and then threshing and weighing the grain.

Since the inception of these competitions, the Judges have been Departmental Officers attached to the Wheat Branch. All the competition crops in each zone are inspected and the awards for the championship prizes made by the same Judge.

The Season.

Following a dry summer the season commenced well with above average falls during the early part of March, but unfortunately these early rains were



not followed up by satisfactory timely falls, April, May and June being months of abnormally low average rainfall. The lower rainfall areas suffered most severely through the whole of this period and in the latter part, the adverse conditions were very severely felt in the Northern and North Eastern areas.

Widespread rains mainly in the latter part of July altered the whole seasonal outlook and the crops made a remarkable recovery. The August rains, although disappointing, were well spread over the month and enabled the crops to make good growth. The rainfall in September and October was, however, well below normal, and the cumulative effect of the rain shortage through the whole of the season, especially from August onwards, has been reflected in the yields.

ZONE 1.

Judge—J. H. Langfield, Manager Merredin Research Station.

Competitors—Moora, 4; Three Springs, 6; Royal, 1; Total, 11.

The rainfall recorded at the centres concerned was as follows:—

——	Jan.	Feb	Mar.	Apl	May.	June	July.	Aug	Sept.	Oct	Total	Nov	Dec.	Total for Year.
					—Growing Period.—									
Moora		5	174	184	151	276	436	169	115	51	1,198	104	1	1,606
Coorow		7	169	175	52	100	357	107	76	32	724	75	49	1,199
Three Springs	17	20	75	172	60	80	312	162	66	17	697	41		1,022
Bindi Bindi			33	146	263	301	59	288	89	12	1,015	96		1,290

Tables showing the Judge's awards and details of the treatment received by the leading competing areas are set out hereunder:-

MOORA AGRICULTURAL SOCIETY

Competitor.	Address.	Variety.	Yield, 1 point per bush	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
			50 pts	10 pts	10 pts	15 pts	15 pts	100 pts.
Tonkin, J. A., & Sons	Coomberdale	Benecubbin	38	9	9	14	14	84
Adams, R. H.	Bindi Bindi	Ranee	37	9	9	13	14	82
Isbister, J.	Moora	Dundee	37	9	8	13	13	80
Hockridge, W. J.	do	Merredin	33	9	9	13	13	77

Mr. J. A. Tonkin & Son's winning crop of "Benecubbin" was grown on salmon gum country which had not been cropped for two years before being ploughed in June 1937, with a mouldboard plough. This land was not touched again until early April when it was springtyne cultivated and then seeded during the last week of April with a combined cultivator-drill, seed and superphosphate being applied at the rate of 60 lb. and 112 lb. per acre respectively. Owing to rank early growth this crop was lightly fed off twice.

The crop of "Ranee" entered by Mr. R. M. Adams was grown on York gum and jam country which had been fallowed in early August, 1937, with a disc plough. No further cultivations were given to the land prior to seeding when it was sown with a combined cultivator-drill during the first week in May; seed and superphosphate being applied at the rates of 50 lb. and 90 lb. per acre respectively.

Mr. J. Isbister's crop of "Dundee" was grown on York and salmon gum country which had been under cultivation for the past 25 years. The land was ploughed in August, 1937, with a disc plough to a depth of approximately 3 inches and cultivated prior to seeding, which was done during the first week of May with a combined cultivator-drill. Seed and superphosphate were applied at the rates of 60 lb. and 105 lb. per acre respectively. This crop had also been fed off in its early stages.

THREE SPRINGS AGRICULTURAL SOCIETY.

Competitor.	Address.	Variety.	Yield, 1 point per bush	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth	Total
			50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts
Franklin, E. W.	Three Springs	Benecubbin	33	8	9	14	14	78
Olden, S. R.	do.	do.	32	9	9	11	13	74
Davey, E.	Arrino	Gluclub	32	7	9	12	12	72
Hebiton, J. K.	Three Springs	Merredin	29	8	9	13	13	72
Williamson, A. M.	do.	Nabawa	30	7	8	14	12	71
Bertiotti, J.	Arrino	Merredin	21	[illegible]	9	13	14	66

The winning crop, "Bencubbin," entered by Mr. E. W. Franklin was grown on York and salmon gum country which had been cleared for approximately 30 years. It was ploughed in July, 1937, with a disc plough to a depth of 4 inches and cultivated during the spring with a springtyne implement. Seeding was carried out during the first week in June; seed and superphosphate being applied at the rates of 50 lb. and 90 lb. per acre respectively.

Mr. S. R. Olden's crop of "Bencubbin" was also grown on York and salmon gum country which had been cleared for 20 years. This land was cultivated twice during July, 1937, with a rigid tyne cultivator. It was again cultivated with the same implement before seeding, when 53 lb. seed and 103 lb. superphosphate per acre were applied by means of a combined cultivator-drill.

The crop of "Gluclub" entered by Mr. E. Davey was grown on jam country which had been ploughed in July, 1937, with a disc plough and ploughed back in April, 1938, just prior to seeding. Seed and superphosphate at the rates of 49 lb. and 90 lb. per acre, respectively, were sown with a combined cultivator-drill during early May.

ROYAL AGRICULTURAL SOCIETY

Competitor.	Address.	Society	Variety.	Yield, 1 point per bush.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
				50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
Tonkin, J. A., & Sons	Coomberdale	Moora	Bencubbin	38	9	9	14	14	84
Adams, R. M.	Bindi Bindi	do.	Ranee	37	9	9	13	14	82
Bothe, B. D.	Coorow	Royal	Bencubbin	36	9	9	14	14	82
Franklin, J. W.	Three Springs	Three Springs	do	33	8	9	14	14	78
Olden, S. R.	do.	do.	do.	32	9	9	11	13	74

Mr. B. D. Bothe's crop of "Bencubbin," which shared second place with Mr. R. M. Adams' crop of "Ranee," was grown on salmon gum country which had been under cultivation since 1914 and was fallowed in July, 1937, with a disc plough to a depth of 3½ inches. It was rigid-tyne cultivated in August and September, 1937, and again in April, 1938. Seeding was carried out during the middle of May; seed and superphosphate were applied at the rates of 60 lb. and 180 lb. per acre respectively.

ZONE 2.

Judge: F. V. Knapp, M.D.A. (Hons.), B.Sc. (Agric.) Agricultural Adviser.

Competitors: Perenjori, 2; Royal, 6. Total, 8.

The rainfall recorded during the year at the centres concerned in this Zone was as follows:—

——	Jan.	Feb.	Mar.	Apl.	May. (Growing Period)	June. (Growing Period)	July. (Growing Period)	Aug. (Growing Period)	Sept. (Growing Period)	Oct. (Growing Period)	Total. (Growing Period)	Nov.	Dec.	Total for year.
Damboring	65	8	178	117	29	98	269	99	86	15	596	53	17	1,034
Perenjori ..	2	5	141	149	43	62	349	108	51	16	629	48	.	974
Bowgada .	33	15	40	102	48	45	251	60	28	15	447	63	2	702
Indarra	26	15	143	96	55	40	327	115	31	8	576	30	1	887

Tables showing the Judge's awards and details of the treatment received by the leading crops are set out below.

PERENJORI AGRICULTURAL SOCIETY.

Competitor.	Address.	Variety.	Yield, 1 point per bush.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
			50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
Davis, S. T.	Bowgada	Merredin	23	8	7	14	13	65
Helwig Bros.	Perenjori	Dundee	21	8	9	12	12	62

The winning crop of "Merredin" entered by Mr. S. T. Davis was grown on York gum, jam and mallee country which had been cleared eleven years. This

land, which is worked on the 3-year rotation (fallow, crop, pasture) was ploughed with a disc cultivating plough in June and August to a depth of 3½ inches. It was then springtyne cultivated during the summer months and again after the heavy rains in March, 1938. Seeding was carried out during the middle of May, the rates of seed and superphosphate being 38 lb. and 112 lb. per acre, respectively.

Messrs. Helwig Bros.' crop of "Dundee" which was awarded second place was planted on country that had previously carried York gum and ti-tree. It was ploughed in July, 1937, to a depth of 3 inches with a disc implement and reploughed in August. It was seeded during the middle of May with a combined cultivator-drill. Seed was sown at the rate of 48 lb. per acre and superphosphate at 90 lbs. per acre.

ROYAL AGRICULTURAL SOCIETY.

Competitor.	Address.	Society.	Variety.	Yield, 1 point per bush.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
				50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
Moore, Hon. T.	Indarra	Royal	Dundee	31	7	9	13	13	73
Butcher, O. J.	Pithara	do.	Gluclub	26	8	9	12	14	69
Bradford, R.	Damboring	do.	Bencubbin	26	8	8	12	14	68
Davis, S. T. ...	Bowgada	Perenjori	Merredin	23	8	7	14	13	65
Browning, L. W. G.	Pithara	Royal	Bencubbin	23	8	9	13	11	64
Sutcliffe, J. A. G.	Damboring	do.	Gluclub	21	7	8	13	14	63
Helwig Bros.	Perenjori	Perenjori	Dundee	21	8	9	12	12	62
Harrington, S. C.	Damboring	Royal	Gluclub	19	8	9	13	12	61

The Hon. T. Moore's winning crop of "Dundee" was grown on land which had previously carried York gum and jam timber. It had been ploughed in August, 1937, with a disc cultivating plough to a depth of three inches, springtyne cultivated in January, 1938, after a heavy thunderstorm, and seeded during the second week of May by means of a combined cultivator-drill. Seed and superphosphate was applied at 45 lb. and 95 lb. per acre respectively. The crop made too rapid early growth and in consequence, was lightly fed off.

Mr. O. J. Butcher's crop of "Gluclub" was grown on land that had previously been timbered with salmon gum, morrel and gimlet. The land, which has been cleared for 18 years, was cultivated in late July, 1937, with a rigid tyne cultivator to a depth of approximately three inches, and springtyne cultivated prior to seeding which was carried out during the middle of May. The rates of seed and superphosphate were 36 lb. and 112 lb. per acre respectively.

The crop of "Bencubbin" entered by Mr. R. Bradford, which was awarded third place, was on country which had previously been timbered with gimlet and been farmed for the past 17 years under a crop and fallow rotation. The land was ploughed in early June, 1937, with a disc cultivating plough to a depth of four inches and springtyne cultivated at the end of August, 1937, and again in April, 1938. It was seeded during the middle of May by means of a combined cultivator-drill with 45 lb. of seed and with an application of 90 lb. of superphosphate per acre.

ZONE 3.

Judge: N. Davenport, B.Sc. (Agric.), Agricultural Adviser.

Competitors: Dowerin, 2; Wyalkatchem, 4; Ballidu, 6; Royal, 2. Total, 14.

The rainfall recorded at centres concerned in this Zone was as hereunder:—

——	Jan.	Feb.	Mar.	Apl.	Growing Period — May.	June.	July.	Aug.	Sept.	Oct.	Total.	Nov.	Dec.	Total for Year.
Dowerin ...	6	1	329	108	71	194	234	91	79	25	694	60	3	1,201
Wyalkatchem	45	1	116	107	39	160	239	85	74	22	619	57	5	950
Ballidu .	64	9	170	134	38	125	261	118	68	23	633	80	20	1,110
Wongan Hills	5	7	151	145	76	237	214	88	124	14	753	85		1,146
Minnivale	67		171	110	40	191	235	76	60	21	632	54		1,043
Calingri .		3	121	146	110	184	314	139	102	37	886	82		1,238
Cowcowing .	23	5	119	105	32	140	180	98	48	34	532	58	5	947

The awards and particulars of the treatment received by the leading crops are as follow:—

BALLIDU AGRICULTURAL SOCIETY.

Competitor.	Address.	Variety	Yield, 1 point per bush	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture	Evenness of Growth.	Total.
			50 pts	10 pts	10 pts.	15 pts.	15 pts	100 pts.
Ackland, J. H.	Wongan Hills	Bencubbin	27	9	9	14	13	72
Mincherton, J., Jun	Ballidu	Gluclub	24	9	9	14	13	69
Beilby, A. H.	do	do	24	8	9	13	12	66
Goodie, H.	West Ballidu	Nabawa	20	9	9	14	13	65
Petchell, R.	do.	Gluclub	23	8	9	14	10	64
Thomas, W.	Ballidu	do	21	8	9	14	11	63

The competition was won by Mr. J. H. Ackland whose crop was grown on land which had originally carried salmon gum, gimlet and mallee. It was rigid tyne cultivated at the end of June, 1937, 2½-3 inches deep, and again in July; springtyne cultivated at the end of August, again in March and April after rains. It was planted with a combined cultivator-drill with 50 lb. of seed and 120 lb. of superphosphate per acre during the second week in May, and harrowed after planting.

Mr. J. Mincherton's crop was grown on land which until six years ago had carried jam, morrel and York gum timber. It was ploughed with a disc-cultivating plough three inches deep during August; springtyne cultivated during April and seeded with a combined cultivator-drill during the second week in May, using 50 lb of seed and 90 lb. of superphosphate per acre.

The entry of Mr. A. H. Beilby was grown on salmon gum and gimlet country. It was ploughed at the end of June, 1937, with a disc cultivating plough three to four inches deep. No further working was given until it was cultivated with a rigid-tyne implement prior to planting with a combined cultivator-drill during the second week in May, using 45 lb. of seed and 112 lb. of superphosphate per acre.

WYALKATCHEM AGRICULTURAL SOCIETY.

Competitor.	Address.	Variety	Yield, 1 point per bush.	Freedom from Weeds	Freedom from Disease	Freedom from Admixture.	Evenness of Growth.	Total.
			50 pts.	10 pts	10 pts	15 pts	15 pts.	100 pts
Slocum, H. H	Wyalkatchem	Bencubbin	26	9	9	14	13	71
McKay, M	Benjaberring	do.	25	9	9	14	13	70
Jones, W. W.	Cowcowing	do	24	8	9	14	13	68
Lawrence, A. E.	Benjaberring	Dundee	21	9	9	14	14	67

Mr. H. H. Slocum's crop which won the competition was grown on light scrub country. It was worked with a rigid-tyne cultivator in June, 1937; with a springtyne cultivator in September and again in March after rain. It was planted with a combined cultivator-drill in mid-May, using 50 lb. of seed and 100 lb. of superphosphate per acre.

A crop of "Bencubbin" entered by Mr. McKay gained second place. It was grown on mixed country, viz., York gum, salmon gum, mallee and tamma. The land was ploughed with a disc cultivating plough during August; springtyne cultivated during October, after rain in March and was then planted with a combined cultivator-drill about 1st May, using 45 lb. of seed and 120 lb. of superphosphate per acre.

Mr. W. W. Jones' crop was grown on salmon gum and mallee country. The land was broken up with a rigid tyne cultivator in June, 1937. It was cross-cultivated with a springtyne implement during August; rigid-tyne cultivated in March after rain, and then planted with a combined cultivator-drill during the first week of May, using 50 lb. of seed and 90 lb. of superphosphate per acre.

DOWERIN AGRICULTURAL SOCIETY.

Competitor.	Address.	Variety.	Yield, 1 point per bush.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture	Evenness of Growth.	Total.
			50 pts.	10 pts	10 pts.	15 pts	15 pts.	100 pts.
Wilmot, H L	Dowerin	Bencubbin	28	9	9	13	14	73
Thomas, T	do	do	24	8	9	13	12	66

Mr. H. L. Wilmot's crop, which also gained second place in the Zone competition, was grown on tamma scrub plain which had been cleared for a number of years. It was ploughed with a disc-cultivating plough in early July, 1937, cultivated with a springtyne implement early in September, again after March rains and then planted with a combined cultivator-drill with rigid-tynes during the second week of May, using 45 lb. of seed and 112 lb. of superphosphate per acre. The crop was harrowed after drilling to kill weeds.

The entry of Mr. T. Thomas was grown on York gum and jam country. It was ploughed with a disc-cultivating plough early in July, 1937, ploughed back with the same implement in April and planted in mid-May with a combined cultivator-drill, using 45 lb. of seed and 90 lb. of superphosphate per acre.

ROYAL AGRICULTURAL SOCIETY.

Competitor	Address	Society	Variety.	Yield, 1 point per bush	Freedom from Weeds	Freedom from Disease	Freedom from Admixture	Evenness of Growth	Total
				50 pts	10 pts	10 pts	15 pts	15 pts	100 pts
Edmonds B J	Calcarra	Royal	Benenbbin	38	9	9	14	14	84
Wilmot, H. L.	Dowerin	Dowerin	do.	28	9	9	13	14	73
Ackland J H.	Wongan Hills	Ballidu	do	27	9	9	14	13	72
Slocum, H. H.	Wyalkatchem	Wyalkatchem	do	26	9	9	14	13	71
McKay, M.	Benjaberring	Wyalkatchem	do.	25	9	9	14	13	70
Minchetton, J., Jun	Ballidu	Ballidu	Gluclub	24	9	9	14	13	69
Thomas, T	Dowerin	Dowerin	Benenbbin	24	8	9	13	12	66
Hesford Bros.	Minnivale	Royal	Gluclub	21	9	9	13	12	64

The crop of "Benenbbin" entered by Mr. B. J. Edmonds, which won the Zone Championship, was grown on old land which originally carried York gum and manna gum. It was ploughed with a mouldboard plough during August, 1937, and cultivated with a springtyne implement in the spring. It was seeded with a combined cultivator-drill on the 1st of May, using 60 lb. of seed and 95 lb. of superphosphate per acre.

ZONE 4.

Judge: W. M Nunn, B.Sc. (Agric.), Agricultural Adviser.

Competitors: Nungarin, 3; Mt. Marshall, 2. Total, 5.

The rainfall for the year at Nungarin and Benenbbin was as follows:—

—	Jan.	Feb.	Mar.	Apl.	May.	June.	July.	Aug.	Sept	Oct.	Total.	Nov	Dec.	Total for Year.
					Growing Period									
Nungarin ...	45	23	63	103	41	123	222	133	54	33	606	67	37	944
Benenbbin	34	25	65	94	112	103	171	32	36	51	505	58	1	782

The awards, and details of treatment received by the leading crops are set out hereunder:—

NUNGARIN AND EASTERN DISTRICTS AGRICULTURAL SOCIETY.

Competitor.	Address.	Variety.	Yield, 1 point per bush.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
			50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
Watson Bros.	Nungarin	Bencubbin ..	18	8	9	14	14	63
Creagh Bros., Ltd.	do. .	Noongaar . .	14	8	9	14	13	58
Jolly, H. P.	do. ...	Bencubbin .	13	9	9	14	10	55

Watson Bros.' winning crop of "Bencubbin" was grown on salmon gum country which had been ploughed in July, 1937, to a depth of 3 inches with a disc plough. It was springtyne cultivated in October, again in March, 1938, after heavy rain and then seeded during the last week in April; the rates of seed and superphosphate being 45 lb. and 90 lb. per acre, respectively.

The crop of "Noongaar" entered by Creagh Bros., Ltd., was grown on salmon, gimlet and mallee country which had been ploughed in July, 1937, with a disc plough, springtyne cultivated in August, 1937, and scarified after rain in March and May, 1938. Seeding took place during the second week in June, seed and superphosphate being applied at the rates of 45 lb. and 112 lb. per acre, respectively.

MT. MARSHALL AGRICULTURAL SOCIETY

Competitor.	Address.	Variety.	Yield, 1 point per bush.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
			50 pts.	10 pts.	10 pts	15 pts.	15 pts.	100 pts.
Gilham, F.	Bencubbin	Bencubbin .	16	7	9	12	12	56
Hopwood, B. W. G.	do.	do. .	11	9	9	14	11	54

The winning crop of "Bencubbin" entered by Mr. F. Gilham was on land which had originally been timbered with salmon gum. It was cultivated in June, 1937, with a rigid-tyne cultivator to a depth of 3 inches, and again during August, 1937. During mid-April seed and superphosphate were applied at the rates of 40 lb. and 90 lb., respectively, by means of a combined cultivator-drill.

ROYAL AGRICULTURAL SOCIETY.

Competitor.	Address.	Society.	Variety.	Yield, 1 point per bush.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
				50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
Watson Bros...	Nungarin ..	Nungarin	Bencubbin	18	8	9	14	14	63
Creagh Bros., Ltd.	do.	do. ...	Noongaar	14	8	9	14	13	58
Gilham, F. ..	Bencubbin ..	Mt. Marhsall	Bencubbin	16	7	9	12	12	56
Hopwood, B. W. G.	do. ...	do.	do.	11	9	9	14	11	54

ZONE No. 5.

Judge: W. M. Nunn, B.Sc. (Agric.), Agricultural Adviser.

Competitors: Bruce Rock, 3; Royal, 1. Total, 4..

The rainfall recorded at the centres concerned was as follows:—

——	Jan.	Feb.	Mar.	Apl.	May. (Growing Period)	June.	July.	Aug.	Sept.	Oct.	Total.	Nov.	Dec.	Total for Year.
Bruce Rock	70	9	129	32	84	169	292	90	81	74	790	32	2	1,064
Kellebertin	41	1	114	53	69	172	282	74	57	113	767	29	10	1,015

The Judge's awards, together with the details of the treatments received, are set out in the following table:—

BRUCE ROCK AGRICULTURAL SOCIETY.

Competitor.	Address.	Variety.	Yield, 1 point per bush.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
			50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
Ellis, E. G. & M. P.	Bruce Rock	Gluclub	25	9	8	14	13	69
Wilkins, H. W. ..	do. ..	Bencubbin	21	9	8	14	12	64
Pimlott, S H. ...	Kwolyin .	do.	21	8	9	13	11	62

Messrs. E. G. and M. P. Ellis' winning crop of "Gluclub" was on salmon gum, gimlet and jam country which had been ploughed early in July with a disc plough to an approximate depth of 4 inches. It was harrowed in August, 1937, springtyne cultivated in September, 1937, and April, 1938, and seeded during the first week of May, when 50 lb. seed and 90 lb. superphosphate per acre were applied.

The second award was given to a crop of "Bencubbin" entered by Mr. H. W. Wilkins and grown on salmon gum, gimlet and York gum country. The land was ploughed in July, 1937, with a disc plough and rigid-tyne cultivated in August, September, and April, 1938, just prior to seeding. Seed and superphosphate were applied at the rates of 50 lb. and 84 lb. per acre, respectively.

ROYAL AGRICULTURAL SOCIETY

Competitor.	Address.	Society.	Variety.	Yield, 1 point per bush.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
				50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
Ellis, E. G. & M. P.	Bruce Rock	Bruce Rock	Gluclub ...	25	9	8	14	13	69
Diver, L. C. . .	Kellerberrin	Royal	Bencubbin	22	8	9	14	13	66
Wilkins, H. W.	Bruce Rock	Bruce Rock	do.	21	9	8	14	12	64

Mr. L. C. Diver's crop of "Bencubbin" was on salmon gum and gimlet country which had been cultivated in June, 1937, with a springtyne implement. It was rigid-tyne cultivated in July, and cultivated with a springtyne cultivator in August and prior to seeding in May. Rates of seed and superphosphate were 60 lb. and 80 lb. per acre, respectively.

ZONE 7.

Judge: A. S. Wild, B.Sc. (Agric.), Agricultural Adviser.

Competitors: Kulin, 13; Kukerin, 11; Karlgarin, 9; Lake Grace, 10. Total, 43.

The rainfall recorded during the year at stations in this zone was as follows:—

					Growing Period.									
——	Jan.	Feb.	Mar.	Apl.	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Nov.	Dec.	Total for Year.
Karlgarin	96	15	140	19	99	200	207	89	104	90	789	53	5	1,117
Kondinin	97	39	183	28	102	140	243	115	79	28	707	44	6	1,104
Kulin	40	13	251	24	112	166	311	135	138	73	935	52	34	1,349
Lake Grace	71		270	30	68	155	219	128	118	92	780	51	28	1,230
Kukerin ...	188		158	42	95	169	220	170	143	92	889	48	16	1,341

The awards made are set out below:—

KARLGARIN AGRICULTURAL SOCIETY.

Competitor.	Address.	Variety	Yield, 1 point per bush.	Freedom from Weeds.	Free dom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
			50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
Finemore, A. . .	Karlgarin . .	Bencubbin .	31	9	9	12	13	74
Richter Bros. . .	do. . .	do. ...	28	9	9	13	13	72
Cowling, E. W. ...	Sth. Karlgarin	do . .	27	9	8	13	13	70
Marshall, H. J.	Hyden	do. .	24	9	9	14	13	69
Biglin, E. J.	Karlgarin	do. . .	24	8	9	14	13	68
Grieves, H. F.	Hyden ...	do.	24	9	8	12	13	66
Richter, B. G.	Karlgarin ...	Gluyas Early	23	9	7	14	13	66
Medcalf, C. W.	do.	Bencubbin ...	23	8	9	12	13	65
James, S. W.	do.	do. ...	17		9	14	12	59

The winning crop of "Bencubbin" of Mr. A. Finemore was grown on salmon gum, mallee and gimlet country which had been cropped for many years and which was rigid-tyne cultivated 3-4 inches deep in early August. It was cultivated with the same implement 3 inches deep in September, and again early in March, and planted with a combined cultivator-drill the second week in May. Fifty pound of seed and 125 lb. superphosphate were applied per acre.

Messrs. Richter Bros.' crop of "Bencubbin" was grown on a similar type of land which had been mouldboard ploughed 3 inches deep in July. The ploughed land was rigid-tyne cultivated in late August and early March and the crop was planted the second week in May with a combined cultivator-drill. The respective rates of application of seed and superphosphate were 50 lb. and 110 lb. per acre.

Mr. E. W. Cowling's entry was also of the variety "Bencubbin." The land on which the crop was planted was salmon gum and jam country which had been ploughed 3 inches deep with a disc implement the previous July, and which received a springtyne cultivation just prior to seeding, which took place in mid-May. Seed and superphosphate were applied at the respective rates of 50 and 90 lb. per acre.

KULIN AGRICULTURAL SOCIETY.

Competitor.	Address.	Variety.	Yield. 1 point per bush	Freedom from Weeds.	Freedom from Disease	Freedom from Admixture.	Evenness of Growth.	Total.
			50 pts	10 pts	10 pts.	15 pts.	15 pts.	100 pts.
Evans, H R.	Kulin Rock	Bencubbin	35	9	8	14	14	80
Clayton, R., & Sons	Jitarning	do	31	9	9	14	14	77
Parker, C. W.	Jilakin	do.	31	9	8	14	14	76
Wilson, J. C.	Kulin	do.	32	9	8	13	13	75
Freebairn, F. S	Kulin Rock	do.	29	9	8	13	14	73
Ryan, M.	Kulin	Gluclub	28	9	9	13	13	72
Roberts, J. F.	Kulin Rock	Bencubbin	28	8	9	13	13	71
Smith & Riseborough	Jitarning	Gluyas Early	25	9	9	14	14	71
Bowey, P. J.	Kulin	Ford	26	9	8	13	14	70
Meikle, P.	Kulin Rock	Sword	28	7	8	13	12	68
Parker, J. W	Kulin	Gluclub	27	7	8	13	13	68
Gray, J. S	Jilakin	do.	23	9	8	13	13	66
Stubbs, W.	Kondinin	Bencubbin	24	8	9	12	13	66

This competition was won by an entry of the variety "Bencubbin" submitted by Mr. H. R. Evans. The land was salmon gum, gimlet and York gum country which had been ploughed 3½ inches deep with a mouldboard plough in early June, cultivated with a rigid-tyne cultivator in early September and disc cultivated 2 inches deep prior to seeding. The crop was sown the first week in May with a disc drill with light harrows attached, 65 lb. of seed and 90 lb. of superphosphate being applied per acre. The crop was heavily fed off by sheep until late July.

Messrs. R. Clayton & Sons' crop of "Bencubbin" was grown on York gum and jam country, which was ploughed 2½ inches deep with a mouldboard plough in July. It was rigid-tyne cultivated in early August, springtyne cultivated in September, and again in April, and the crop was planted with a combined cultivator-drill in mid-May. Forty-two pound of seed and 90 lb. of superphosphate were applied per acre.

Mr. C. W. Parker's crop of "Bencubbin" was grown on jam, York gum, salmon gum and morrel country which had been ploughed with a disc implement 3 inches deep in July. This was rigid-tyne cultivated in October, springtyne cultivated in March and the crop was planted the first week in May with a combined cultivator-drill, 50 lb. of seed and 94 lb. of superphosphate being used per acre.

LAKE GRACE AGRICULTURAL SOCIETY.

Competitor.	Address.	Variety.	Yield, 1 point per bush.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
			50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
Garard, T.	Pingaring	Bencubbin	27	9	8	13	14	71
Coad, H. J.	Lake Grace	Gluclub	28	8	8	13	13	70
Curwood, W.	Lake Biddy	Bencubbin	27	8	9	11	14	69
English, I. P.	Lake Grace	Gluclub	24	9	8	14	14	69
Kean Bros.	Pingaring	Bencubbin	25	9	9	12	13	68
Bishop, S. J.	Lake Grace	do.	24	9	9	12	13	67
Fry, E. H.	Nth. Lake Grace	Gluclub	23	9	8	13	14	67
Curwood, D. J. V.	Lake Biddy	do.	25	8	8	13	12	66
Kay, W.	Lake Grace	Bencubbin	23	8	8	12	14	65
Hadden, R. T.	Pingaring	Gluclub	23	8	8	12	13	64

The winning crop of Mr. T. Garard, was of the variety "Bencubbin" grown on salmon gum and mallee country which had been ploughed 4 inches deep with a disc plough in July. It was springtyne cultivated in September, again in April and planted with a combined cultivator drill during the second week in May. Sixty pounds of seed and 90 lb. of superphosphate per acre were used.

Mr. H. J. Coad's crop of "Gluclub" was planted on salmon gum, gimlet and morrel country which had been ploughed 3 inches deep with a disc plough in July, rigid-tyne cultivated in September and again in March. It was planted during the third week in April with a combined cultivator-drill, and 45 lb. of seed and 120 lb. of superphosphate were used per acre.

Mr. W. Curwood's crop of "Bencubbin" was grown on salmon gum, morrel, gimlet and boree country. This was disc ploughed 3 inches deep in July. Half the area was springtyne cultivated and the remainder disc-cultivated 2 inches deep in August. It was rigid-tyne and also springtyne cultivated just prior to seeding, which took place during the first week in May. The rates of seed and superphosphate were 50 lb. and 90 lb. respectively per acre.

KUKERIN AGRICULTURAL SOCIETY

Competitor.	Address.	Variety.	Yield, 1 point per bush	Freedom from Weeds	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
			50 pts	10 pts	10 pts.	15 pts.	15 pts.	100 pts
Bennett, R. G	Dumbleyung	Gluclub	38	8	8	13	14	81
Bahr, Ron	Merilup	Bencubbin	30	9	9	13	14	75
English, A. R.	Kukerin	do	30	9	9	13	13	74
Taylor, A J	Dumbleyung	Gluyas Early	28	9	9	13	14	73
Bairstow, F.	Moulyinning	Gluclub	27	9	9	14	13	72
Faulkner, W. J.	North Kukerin	Bencubbin	30	9	7	13	13	72
Joyce, F.	do.	do.	27	9	8	13	14	71
English, J C	Merilup	do.	26	8	8	14	13	69
Kellow, J.	North Kukerin	Dundee	21	9	7	14	14	65
Nenke, C. E.	Kukerin	Merredin	20	9	8	14	14	65
Gard, Wm.	Merilup	Bencubbin	23	8	7	13	13	64

Mr R. G. Bennett won this completition with a crop of "Gluclub" planted on morrel country. This was ploughed with a mouldboard plough to a depth of 3 inches in August, springtyne cultivated in September and again in March. It was planted in mid-May with a combined cultivator-drill, 60 lb. of seed and 112 lb. of superphosphate being used per acre.

A crop of "Bencubbin" entered by Mr. R. Bahr gained second place. This was grown on York gum and morrel country which was ploughed with a mouldboard plough 3-4 inches deep in August. In September it was rigid-tyne cultivated, and springtyne cultivated prior to seeding which was carried out during the fourth week in May, using a combined cultivator-drill, 45 lb. of seed and 40 lb. of superphosphate being applied per acre.

Mr. A. R. English's crop of "Bencubbin" was grown on York gum and mallee country which was rigid-tyne cultivated 3-4 inches deep late in June. It was culti-

vated 3-4 inches deep late in June. It was cultivated with the same implement in September and March and planted with a combined cultivator-drill in mid-May. Forty-eight pounds of seed and 90 lb. of superphosphate were used per acre.

ROYAL AGRICULTURAL SOCIETY.

Competitor.	Address.	Society.	Variety.	Yield, 1 point per bush.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
				50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
Bennett, R. G.	Dumbleyung	Kukerin	Gluclub	38	8	8	13	14	81
Evans, H. R.	Kulin Rock	Kulin	Bencubbin	35	9	8	14	14	80
Clayton, R., & Sons	Jitarning	do.	do.	31	9	9	14	14	77
Bahr, Ron.	Merilup	Kukerin	do.	30	9	9	13	14	75
Finemore, A.	Karlgarin	Karlgarin	do.	31	9	9	12	13	74
Richter Bros.	do.	do	do	28	9	9	13	13	72
Garard, T.	Pingaring	Lake Grace	do.	27	9	8	13	14	71
Coad, H. J.	Lake Grace	Lake Grace	Gluclub	28	8	8	13	13	70

ZONE 8.

Judge: G. L. Throssell, Dipl. Agric., Agricultural Adviser.

Competitors: Quairading, 4; Wickepin, 11; Gnowangerup, 10; Royal, 6. Total, 31.

The rainfall for the year at centres concerned in Zone 8 is set out below.

——	Jan.	Feb.	Mar.	Apl.	May.	June.	July.	Aug.	Sept.	Oct.	Growing Period. Total.	Nov.	Dec.	Total for Year.
New Norcia	4	2	183	182	105	274	325	196	143	68	1,111	71	5	1,558
Muresk	16	11	144	105	104	188	439	133	101	34	955	59	55	1,345
York	24	12	226	95	162	217	416	159	145	52	1,151	60	3	1,571
Quairading	112	23	308	49	104	173	375	110	99	64	925	39	18	1,469
Wickepin	11		202	58	128	161	375	140	137	51	992	63	18	1,344
Noman's Lake	9	1	173	57	192	161	382	226	181	80	1,222	48	16	1,526
Broomehill	9	3	151	46	126	180	290	153	161	64	974	29	25	1,237
Gnowangerup	13		129	35	105	178	238	144	165	89	919	9	19	1,124
Borden	58		111	46	99	154	137	182	78	48	698	6	14	933

The awards are set out below:—

QUAIRADING AGRICULTURAL SOCIETY.

Competitor.	Address.	Variety.	Yield, 1 point per bush.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
			50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
Hull, W.	Quairading	Bencubbin	29	8	9	13	13	72
Powell, G. J.	do.	Ranee	26	9	9	14	13	71
Forrest, A.	do.	Gluclub	27	9	9	12	13	70
Campbell, L. T.	Sth. Caroling	Sword	25	8	9	13	12	67

The winning crop entered by Mr. W. Hull was a crop of "Bencubbin" grown on land which originally carried mallee and scrub and which had been cropped three times previously. It was disc ploughed to three inches deep in September and scrub raked and harrowed in October and sown with a sunder-seeder on 28th April, 48 lbs. seed and 130 lbs. superphosphate being applied.

The entry of Mr. G. J. Powell, which gained second place, was of the variety "Ranee." The original timber was jam. The land was cultivated with a rigid-tyne cultivator in July and August to a depth of 3 inches, again in September with the same implement, and springtyne cultivated in March. The crop was sown in the middle of May, seed and superphosphate being applied at the rate of 45 lbs. and 112 lbs. respectively.

Mr. A. Forrest's crop of "Gluclub" was on jam and York gum country which was disc ploughed 4 inches deep at the end of June and springtyne cultivated in September and April. It was seeded during the third week in May, seed and superphosphate being sown at the rate of 48 lbs. and 122 lbs. respectively.

WICKEPIN AGRICULTURAL SOCIETY.

Competitor.	Address.	Variety.	Yield, 1 point per bush.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
			50 pts.	10 pts	10 pts.	15 pts.	15 pts.	100 pts.
Fleay, E. H, & Son	Wickepin	Bencubbin	29	9	8	14	13	73
Doncan, E. E.	do.	do.	29	8	8	14	13	72
McDougall, R.	do.	do.	28	8	9	14	12	71
Dalton, L. C.	do.	do.	28	8	8	14	13	71
Fleay Bros.	do.	Totadgin	27	9	9	13	13	71
McDougall, K.	Tinkurrin	Waratah	28	8	8	14	12	70
Hosken Bros.	Wickepin	Bencubbin	26	9	8	14	13	70
McDougall, C.	Tinkurrin	Sword	26	9	8	13	13	69
McDonald, W. G.	Noman's Lake	do	24	9	9	13	14	69
McDougall, M.	Tinkurrin	Dundee	23	8	8	13	12	64
Cockram & Ballard	do.	Merredin	23	7	8	13	13	64

Messrs. E. H. Fleay & Son won this competition with a crop of "Bencubbin" grown on country which originally carried York gum, morrel and jam and which had been cropped four times previously. The land was ploughed three inches deep with a disc-cultivating plough in July and springtyne cultivated in March. It was planted during the middle of May and 50 lbs. of seed and 70 lbs. of superphosphate were applied per acre.

Mr. E. E. Doncan's entry which gained second place was also the "Bencubbin" variety. The land, which was jam and York gum country, had been cropped three times and was ploughed with a mould-board plough in August three to four inches deep and springtyne cultivated in September and March. Fifty-two pounds of seed and 90 lb. of superphosphate were applied per acre.

Mr. R. McDougall's crop of "Bencubbin" was grown on York gum, jam, morrel and salmon gum country. The land was ploughed with a mouldboard plough in August, three inches deep, and springtyne cultivated in October, the end of March and mid-May and was planted the third week in June. Seed and superphosphate were applied at the rate of 50 lbs. and 90 lbs. per acre respectively.

GNOWANGERUP AGRICULTURAL SOCIETY.

Competitor.	Address.	Variety	Yield, 1 point per bush.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
			50 pts	10 pts	10 pts.	15 pts.	15 pts.	100 pts.
Dolley, S. H. G.	Jacketup	Bencubbin	35	9	9	14	13	80
Wright, E. H.	Pallinup	do.	34	9	8	14	13	78
Thomson & Hill	Jacketup	Rajah	31	9	9	13	14	76
Wellard & Wellard	Gnowangerup	Bencubbin	31	9	9	14	12	75
Formby, R., & Co.	do.	do.	29	9	9	14	13	74
Davis, N. P.	do.	Dundee	27	9	9	13	13	71
Stewart, W. B.	Borden	Gallipoli	26	9	9	13	13	70
Cockram, C. E.	Pallinup	do.	27	8	9	13	12	69
McDonald, J. V. & A. R.	Gnowangerup	Ghandi	25	9	9	13	13	69
House, D. K.	do.	Gallipoli	25	8	9	13	12	67

Mr. S. H. G. Dolley's crop of "Bencubbin" which won the competition was grown on York gum, salmon gum and morrel country which had been ploughed with a mouldboard plough 3½ inches deep in July and early August, and cultivated with a springtyne cultivator in September, April and early May; the crop was sown the third week in May with a combined cultivator-drill, 54 lbs. seed and 135 lbs. of superphosphate being used per acre.

Mr. E. H. Wright's entry of "Bencupbin" was planted on York gum, whitegum and manna country which was mould-board ploughed 3½ inches deep in August and springtyne cultivated in October, March and April. It was sown at the end of May, 65 lbs. of seed and 90 lbs. superphosphate being applied per acre.

Messrs. Thomson & Hill's crop of "Rajah" was grown on salmon and manna gum country which was ploughed to a depth of 3½ inches with a mould-board implement in July and cultivated with a springtyne cultivator in September,

March and May. It was planted at the rate of 45 lbs. of seed and 112 lbs. of superphosphate per acre in mid June.

ROYAL AGRICULTURAL SOCIETY.

Competitor.	Address.	Society.	Variety.	Yield. 1 point per bush.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
				50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
Batchelor, A. J.	Broomehill	Royal	Bencubbin	37	9	9	13	13	81
Dolley, S. H. G	Jacketup	Gnowangerup	do.	35	9	9	14	13	80
Burges, W. G.	Wilberforce	Royal	Dundee	36	8	9	13	13	79
Wright, E. H.	Pallinup	Gnowangerup	Bencubbin	34	9	8	14	13	78
Prideaux, J. S.	Noman's Lake	Royal	do.	30	9	9	14	14	76
Boyle, T. W.	York	do.	do.	30	9	9	14	13	75
Taylor, C. ..	Broomehill	do.	do.	30	9	9	13	13	74
Fleay, E. H., & Son	Wickepin	Wickepin	do.	29	9	8	14	13	73
Hull, W.	Quairading	Quairading	do	29	8	9	13	13	72
Doncan, E. E.	Wickepin	Wickepin	do	29	8	8	14	13	72
Powell, G. J.	Quairading	Quairading	Ranee	26	9	9	14	13	71
Grove, F. P.	New Norcia	Royal	Bencubbin	22	9	7	14	13	65

The crop which won the Zone Championship was entered by Mr. A. J. Batchelor of Broomehill and was of the variety "Bencubbin." This had been grown on York gum, white gum, morrel and jam country, which had been cropped once previously. It was ploughed with a mouldboard plough three inches deep in early August, springtyne cultivated at the end of September and again prior to seeding. It was planted with a combined cultivator-drill, seed and superphosphate being applied at the rates of 60 lbs. and 90 lbs. per acre respectively.

ZONE 9.

Judge—A. S. Wild, B.Sc.(Agric.), Agricultural Adviser.

The four competitors in this zone all entered through the Phillips River Agricultural Society.

The rainfall recorded at Ravensthorpe and Mt. Short was as follows:—

——	Jan.	Feb.	Mar.	Apl.	May (Growing Period)	June	July.	Aug.	Sept.	Oct.	Total.	Nov.	Dec.	Total for Year.
Ravensthorpe	236	21	93	118	135	252	206	133	76	60	862	35	40	1,408
Mt. Short	265	29	99	110	100	246	204	112	91	73	826	52	43	1,424

The awards are set out in the following table: —

PHILLIPS RIVER AGRICULTURAL SOCIETY.

Competitor.	Address.	Variety.	Yield, 1 point per bush.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
			50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
Campbell, J. ..	Mt. Short	Bencubbin	24	9	8	14	14	69
Bebbington, F. J. S.	Ravensthorpe	Totadgin	23	9	9	14	13	68
Daw, F. E. ..	do.	Nabawa	24	9	8	13	12	66
Chambers Bros.	do.	Ford	16	9	8	12	12	57

Mr. J. Campbell's winning crop of "Bencubbin" was grown on jam, salmon gum and mallee country which had been cropped for many years. It was ploughed with a mouldboard plough 3½-4 inches deep in June, 1937, springtyne cultivated in September and prior to planting. The crop was sown the first week in May, 45 lbs. of seed and 85 lbs. of superphosphate being applied.

Mr. F. J. S. Bebbington's crop of "Totadgin," which gained second place, was grown on mallee and salmon gum country which was ploughed 3 inches deep late in August with a disc plough and springtyne cultivated shortly after. It was planted the fourth week in May, 45 lbs. of seed and 90 lbs. of superphosphate being used per acre.

The crop of "Nabawa" entered by Mr. F. E. Daw, which was placed third, was grown on mallee country. This was ploughed in August 2½ to 3 inches deep

with a disc implement and rigid-tyne cultivated prior to seeding, which was carried out during the fourth week of May, 45 lbs. and 90 lbs. being the respective rates of seed and superphosphate applications.

ENTRIES.

Entries totalling 104 were received from 17 District Agricultural Societies. The Royal Agricultural Society received 16 entries direct, making the total number of competitors 120.

The following table shows the number and the average yield obtained each year since the competition was inaugurated:—

Year.	Number of District Agricultural Societies Competing.	Number of Competitors.	Average Yield of Competitors.	Average Yield for State.
			Bushel	Bushel
1921	...	15	25	10·4
1922	..	32	24	8·9
1923	12	82	29	11·4
1924	15	70	31	12·8
1925	13	59	22·5	9·7
1926	11	99	24·5	12·0
1927	10	100	26·9	12·1
1928	13	114	22·5	10·1
1929	12	156	21·7	11·0
1930	15	165	27·4	13·3
1931	13	110	27·4	13·1
1932	17	168	29·3	12·3
1933	17	130	27·2	11·7
1934	17	114	26·8	9·8
1935	16	97	24·8	9·2
1936	12	80	21·0	8·4
1937	15	138	25·7	11·9
1938	17	120	26·3	10·6*

* Estimate.

VARIETIES.

The most outstanding variety this year was the standard midseason maturing variety "Bencubbin," which comprised 62 of the 120 competing crops. This variety also won fourteen of the seventeen district competitions as well as five of the eight zone championships, while two of the three crops which won the special prize for the highest calculated bushel yield per acre, viz. 38 bushels, were also of the same variety—the other being "Gluclub." Twenty-one entries were of the variety "Gluclub" which was placed first in two district competitions and two zone championships. The varieties "Merredin" and "Dundee" each won a district competition and the former one zone championship.

The details concerning the individual varieties were as follows:—

Bencubbin (62); Gluclub (21); Dundee (8); Merredin (6); Sword (4); Nabawa, Gallipoli and Gluyas Early (3); Ford, Totadgin and Ranee (2); and Noongaar, Waratah, Rajah and Ghandi (1). Total, 120.

YIELDS.

The special prize of £5 5s., for the competitor obtaining the highest calculated yield per acre was divided among three competitors, viz., Messrs. J. A. Tonkin & Sons, Coomberdale; B. J. Edmonds, Calcarra; and R. G. Bennett, Dumbleyung, who each obtained a yield of 38 bushels per acre.

The winners of this prize since 1925 are:—

	Bush. per acre.
1925—Hebiton & Sons, Three Springs—Nabawa	34
1926—Cumming Bros., Carnamah—Yandilla King	38
1927—A. W. Parkinson, Gnowangerup—Yandilla King ...	40
1928—A. W. Parkinson, Gnowangerup—Yandilla King ...	40
1929—C. E. Cockram, Pallinup—Yandilla King	46
1930—C. Smith & Sons, Yarding—Gluclub	43
1931—H. O. Beeck, Gnowangerup—Yandilla King	42
1932—F. S. Freebairn, Jilakin—Gluclub	47
1933—D. Davis, Gnowangerup—Bencubbin	43
1934—C. E. Cockram, Pallinup—Free Gallipoli	40
1935—E. Davis, Gnowangerup—Bencubbin	41
1936—C. E. Cockram, Pallinup—Free Gallipoli	30
1937—A. R. English, Kukerin—Bencubbin	41
1938—A. J. Tonkin & Sons, Coomberdale—Bencubbin ...	38
1938—B. J. Edmonds, Calcarra—Bencubbin	38
1938—R. G. Bennett, Dumbleyung—Gluclub	38

Of the 120 entries in this year's competition, sixty-three were calculated to yield 24 to 30 bushels; sixteen 31 to 36 bushels; three 37 bushels, and three 38 bushels per acre.

The list of the competitors who obtained 30 bushels and over is given below:—

Zone.	Competitor.	Address.	Society.	Variety.	Estimated Yield.
1	Tonkin, J. A., & Sons ...	Coomberdale...	Moora ...	Bencubbin ...	38
3	Edmonds, B. J. ...	Calcarra ...	Royal ...	do. ...	38
7	Bennett, R. G. ...	Dumbleyung...	Kukerin ...	Gluclub ...	38
1	Adams, R. H.	Bindi Bindi...	Moora ...	Ranee ...	37
1	Isbister, J.	Moora ...	do. ...	Dundee ...	37
8	Batchelor, A. J. ...	Broomehill ...	Royal ...	Bencubbin ...	37
1	Bothe, B. D.	Coorow ...	do.	do. ...	36
8	Burges, W. G.	Wilberforce ...	do.	Dundee ...	36
7	Evans, H. R.	Kulin Rock ...	Kulin ...	Bencubbin ...	35
8	Dolley, S. H. G. ...	Jacketup ...	Gnowangerup	do. ...	35
8	Wright, E. H.	Pallinup ...	do. ...	do. ...	34
1	Hockridge, W. J. ...	Moora ...	Moora ...	Merredin ...	33
1	Franklin, E. W. ...	Three Springs	Three Springs	Bencubbin ...	33
1	Olden, S. R.	do. ...	do. ...	do. ...	32
1	Davey, E.	Arrino ...	do. ...	Gluclub ...	32
7	Wilson, J. C.	Kulin ...	Kulin ...	Bencubbin ...	32
2	Moore, Hon. T. ...	Indarra ...	Royal ...	Dundee ...	31
7	Finemore, A.	Karlgarin ...	Karlgarin ...	Bencubbin ...	31
7	Clayton, R., & Sons ...	Jitarning ...	Kulin ...	do. ...	31
7	Parker, C. W.	Jilakin ...	do.	do. ...	31
8	Thomson & Hill ...	Jacketup ...	Gnowangerup	Rajah ...	31
8	Wellard & Wellard ...	Gnowangerup	Gnowangerup	Bencubbin ...	31
1	Williamson, A. M. ...	Three Springs	Three Springs	Nabawa ...	30
7	Bahr, Ron.	Merilup ...	Kukerin ...	Bencubbin ...	30
7	English, A. R.	Kukerin ...	do. ...	do. ...	30
7	Faulkner, W. J. ...	Nth. Kukerin	do. ...	do. ...	30
8	Prideaux, J. S. ...	Noman's Lake	Royal ...	do. ...	30
8	Boyle, T. W.	York	do.	do. ...	30
8	Taylor, Cyril	Broomehill ...	do.	do. ...	30

The high yields obtained by many of the individual competitors and an average yield of 26.3 bushels per acre for the whole competition are distinctly creditable in a season such as has been experienced. They indicate too, that the crop competitions are achieving their objects in raising the standard of farming methods of the State.

LOCAL CROP COMPETITIONS, 1938.

I. THOMAS, Superintendent of Wheat Farming.

In addition to the 50 Acre Crop Competitions conducted by the Royal and District Agricultural Societies under the Zone System several separate competitions were conducted.

The Bruce Rock, Karlgarin, Koorda and Merredin Agricultural Societies conducted Fallow and Crop Competitions, and the Toodyay Agricultural Society and the Wialki Branch of the Wheat Growers' Union each conducted a 50 Acre Crop Competition under the same conditions as govern the Royal Agricultural Society's competition.

The particulars of the respective competitions are as follow:—

BRUCE ROCK AGRICULTURAL SOCIETY.

50 Acre Fallow and Crop Competition.

Judge:—W. M. Nunn, B.Sc. (Agric.), Agricultural Adviser.

The rainfall recorded at Bruce Rock during the year was as follows:—

Station.	Jan.	Feb.	Mar.	Apl.	Growing Period. May.	June.	July.	Aug.	Sept.	Oct.	Total.	Nov.	Dec.	Total for Year.
Bruce Rock .	70	9	129	32	84	169	292	90	81	74	790	32	2	1,064

The judge's awards are shown in the following table:—

BRUCE ROCK AGRICULTURAL SOCIETY.

Competitor.	Address.	Variety	Yield.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total for Crop.	Total for Fallow*.	Total.
			50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.	100 pts.	200 pts.
Fuchsbichler, M.	Bruce Rock .	Totadgin	17	9	9	13	14	62	86	148
Buller, A. M.	do.	Dundee	19	8	9	14	14	64	83	147

* Fallow Section judged in March. 1938.

The combined crop and fallow competition was won by Mr. M. Fuchsbichler, whose competing area was salmon gum and gimlet country which had been cropped for many years and which had been cultivated to a depth of 3½ inches in June, 1937, with a rigid-tyne cultivator. It was cultivated again with the same implement in August and spring-tyne cultivated in September and after rain in April. The crop was of the variety "Totadgin" and was planted during the fourth week in May, the rates of seed and superphosphate being respectively 45 lbs. and 120 lbs. per acre.

Mr. A. M. Buller's entry was on a similar type of country that had also been cultivated 3 inches deep in June, 1937, with a rigid-tyne cultivator. Further cultivations were given with the same implement in August and November and the variety "Dundee" was sown the first week in May. 45 lbs. of seed and 90 lbs. of superphosphate were used per acre.

KARLGARIN AGRICULTURAL SOCIETY.

Fallow and Crop Competition.

Judge: A. S. Wild, B.Sc. (Agric.), Agricultural Adviser.

The rainfall recorded at Karlgarin during the year was as follows:—

Station.	Jan.	Feb.	Mar.	Apl.	Growing Period. May.	June.	July.	Aug.	Sept.	Oct.	Total.	Nov.	Dec.	Total for Year.
Karlgarin	96	15	140	19	99	200	207	89	104	90	789	53	5	1,117

The Judge's awards are shown in the following table:—

KARLGARIN AGRICULTURAL SOCIETY.

Competitor.	Address.	Variety.	Yield.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total for Crop.	Total for Fallow.	Total.
			50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.	100 pts.	200 pts.
Finemore, A.	Karlgarin	Bencubbin	31	9	9	12	13	74	86	160
Richter Bros.	do.	do	28	9	9	13	13	72	86	158
Biglin, E. J.	do.	do	24	8	9	14	13	68	86	154
Medcalf, C. W.	do.	do.	23	8	9	12	13	65	87	152
James S. W.	do.	do.	17	7	9	14	12	59	88	147

The fallow competition was judged in February, 1938.

The competition was won by Mr. A. Finemore. This entry originally carried salmon gum, mallee and gimlet timber and had been rigid-tyne cultivated 3-4 inches deep in early August, 1937, and worked 3 inches deep with the same implement in September, and again in early March. The crop which was of the variety "Bencubbin" was planted with a combined cultivator-drill during the second week in May, seed and superphosphate being applied at the rates of 50 lbs. and 125 lbs. respectively.

Messrs. Richter Bros. gained second place with a crop of "Bencubbin" grown on salmon gum, mallee and gimlet country. This had been ploughed in July with a mouldboard plough 3 inches deep, and subsequently was rigid-tyne cultivated 3 inches deep late in August and again in early March. The crop was planted during the second week in May, 50 lbs. of seed and 110 lbs. superphosphate being used per acre.

Mr. E. J. Biglin entered a crop of "Bencubbin" grown on salmon gum, gimlet and mallee country. This was mouldboard ploughed 3 inches deep in July and rigid-tyne cultivated in mid-August and March. It was planted with a combined cultivator-drill during the fourth week in April, and 45 lbs. of seed and 90 lbs. superphosphate per acre were applied.

KOORDA AGRICULTURAL SOCIETY.

Judge:—W. M. Nunn, B.Sc. (Agric.), Agricultural Adviser.

The rainfall recorded at Booralaming during the year was as follows:—

Station.	Jan.	Feb.	Mar.	Apl.	May	June.	July.	Aug.	Sept.	Oct.	Total.	Nov.	Dec.	Total for Year.
					Growing Period.									
Booralaming .	18	2	137	119	49	131	211	83	40	49	563	48	10	897

The Judge's awards and cultural details of the competitors were as follows:—

KOORDA AGRICULTURAL SOCIETY.

Competitor.	Address.	Variety.	Yield.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total for Crop.	Total for Fallow*.	Total.
			50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.	100 pts.	200 pts.
Best, R. T.	Booralaming	Bencubbin	19	8	9	14	14	64	76	140
Sharman, R. ..	do. ...	do.	14	8	9	13	12	56	83	139

* The Fallow Competition was judged on 1st March, 1938.

There were five competitors in the fallow competition but only two of these entered the crop competition.

The combined fallow and crop competition was won by Mr. R. T. Best, whose competing area was salmon gum and gimlet country. This was ploughed 5 inches deep with a mouldboard plough at the end of June, 1937. It was disc cultivated in

September and springtyne cultivated in March. The variety "Bencubbin" was planted on 20th April and the rates of application of seed and superphosphate were 50 lbs. and 90 lbs. per acre, respectively.

Mr. H. Sharman entered a similar class of country and used a rigid-tyne cultivator for the initial operation, working to a depth of 3 inches. It was cultivated with the same implement in August, springtyne cultivated in December, and rigid-tyne cultivated in April, both the December and April workings being done when the mulch was dry. Seeding took place during the second week in May, and 60 lbs. of seed and 90 lbs. of superphosphate were sown per acre.

MERREDIN AGRICULTURAL SOCIETY.

Judge:—W. M. Nunn, B.Sc. (Agric.), Agricultural Adviser.

The rainfall recorded at Burracoppin, Merredin and Belka during the year is shown in the following table:—

Station	Jan.	Feb	Mar	Apl	Growing Period May.	June.	July	Aug	Sept.	Oct	Total	Nov.	Dec.	Total for Year.
Burracoppin	50		62	60	73	88	186	78	56	19	500	58	17	747
Merredin	57	3	89	78	85	108	184	87	113	30	667	49	21	964
Belka	97		81	59	54	172	288	80	81	37	712	37	11	997

The awards and cultural details are shown below:

MERREDIN AGRICULTURAL SOCIETY.

Competitor	Address	Variety	Yield	Freedom from Weeds	Freedom from Disease	Freedom from Admixture.	Evenness of Growth	Total for Crop	Total for Fallow*	Total.
			50 pts	10 pts	10 pts	15 pts	15 pts	100 pts	100 pts.	200 pts.
McPharlin, E. P. S. & Sons	South Burracoppin	Bencubbin	17	9	9	14	12	61	88	149
Harling, H. H.	Belka	do.	18	8	9	13	12	60	85	145
Flockart, I. H.	Merredin	do	16	7	9	14	12	58	82	140

* The Fallow Competition was judged on 17th March, 1938.

The competition was won by Messrs. E. P. S. McPharlin & Sons, of South Burracoppin. Their competing area was salmon gum and mallee country which had been cultivated 2½ inches deep the second week in June, 1937, with a rigid-tyne cultivator. It received two further workings with the same implement in August and September. The variety "Bencubbin" was sown the third week in May at the rate of 45 lbs. per acre with 120 lbs. of superphosphate per acre.

Mr. H. H. Harling, of Belka, was awarded second place. A competing area of a similar type of country was entered by this competitor and he also used a rigid-tyne cultivator for the initial operation, working to a depth of 2½-3 inches. It was rigid-tyne cultivated in August and spring tyne cultivated in November. The variety "Bencubbin" was sown in mid-May, the rates of application of seed and superphosphate being 45 lbs. and 112 lbs. respectively.

Mr. I. H. Flockart's competition crop was on salmon gum and gimlet country which was rigid-tyne cultivated 2½-3 inches deep in July and worked with the same implement in January after rain. The variety "Bencubbin" was planted late in May and 45 lbs. of seed and 112 lbs. of superphosphate were used per acre.

TOODYAY AGRICULTURAL SOCIETY.

Judge:—F. V. Knapp, M.D.A. (Hons.), B.Sc. (Agric.), Agricultural Adviser.

The rainfall recorded at the centre concerned during the growing period was as follows:—

Station.	Jan.	Feb.	Mar.	Apl.	Growing Period. May.	June.	July.	Aug.	Sept.	Oct.	Total.	Nov.	Dec.	Total for Year.
Toodyay	1	7	124	116	112	261	478	192	159	70	1,272	69	17	1,606

The awards and details of the treatment received by the leading crops are set out below:—

TOODYAY AGRICULTURAL SOCIETY.

Competitor.	Address.	Variety.	Yield 1 point per bus.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
			50 pts.	10 pts.	10 pts.	15 pts	15 pts.	100 pts.
Ludemann, D.	Wattening	Bencubbin	44	9	9	14	14	90
Hayes, E. D. P.	Toodyay	Ghurka	42	9	9	14	13	87
Lloyd Bros.	Culham	Nabawa	41	9	9	14	14	87
Hayes, E. D. P.	Toodyay	Ghurka	40	9	9	13	13	84
Millington, A.	Wattening	Bencubbin	39	9	8	14	14	84
Lloyd Bros	Culham	Bencubbin	43	8	8	9	13	81
Stevenson, K. J. O.	Wattening	Lotts	34	9	7	13	12	75
Hammersley, V. & Son	Culham	Dundee	32	9	7	14	13	75
Drake-Brockman, R.	Toodyay	Ghurka	28	9	9	13	13	72
Stevenson, K. J. O.	Wattening	Wannon	32	8	7	12	12	71
Wroth, P.	Bejoording	Bena	30	8	7	13	13	71
Clarkson, J. W.	Toodyay	Bena	26	7	8	13	12	66
Hamersley, V. & Son	Culham	Bena	25	8	6	14	12	65
Drake-Brockman, R.	Toodyay	Bena	26	7	7	12	12	64

Mr. Ludemann's winning crop of "Bencubbin" was on light country which had been cleared for a number of years and ploughed 4 inches deep in late August, 1937, with a scrub-plough to deal with regrowth of shrubs. It received no further cultivation until it was seeded in mid-April by means of a combined cultivator-drill, seed and superphosphate being applied at the rate of 48 lbs. and 120 lbs per acre, respectively.

The second prize was awarded to Mr. E. D. P. Hayes' crop of "Ghurka" which was grown on land which originally carried York gum. It had been ploughed in July, 1937, with a mouldboard plough and seeding was carried out, without any further cultivation, during the middle of May, using a combined cultivator-drill. Seed and superphosphate were sown at the rates of 45 lbs. and 100 lbs. per acre, respectively.

Lloyd Bros.' crop of "Nabawa" was on jam country which had been ploughed in August, 1937, with a mouldboard plough. It was cultivated with a springtyne implement before seeding, for which a combined cultivator-drill was used. Seed and superphosphate were applied at the rate of 60 lbs. and 90 lbs. per acre, respectively.

It is interesting to note that the crops of Mr. Hayes, Lloyd Bros. and V. Hamersley & Sons had been fed off in their early stages due to lack of green feed.

The diseases rust and take-all were in evidence and the former affected the varieties "Bena" and "Dundee" most noticeably, thus the planting of these varieties in rust-liable areas cannot be recommended.

THE BEVAN TROPHY.

Judge:—W. M. Nunn, B.Sc. (Agric.), Agricultural Adviser.

The 50 Acre crop competition for the trophy donated by Mr. A .W. Bevan for competition in the Wialki-Bonnie Rock area, was again conducted under the direction of the Wialki Branch of the Wheat Growers' Union.

Conditions governing this competition are the same as for the Royal Agricultural Society's Competitions.

The rainfall recorded at North Wialki is shown below:—

Station.	Jan.	Feb.	Mar.	Apl.	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Nov.	Dec	Total for Year.
					Growing Period.									
North Wialki	58	5	10	91	38	43	180	68	47	14	390	61	66	681

The Judge's awards and details of the treatment received by the winning crop are set out hereunder.

BEVAN CUP—WIALKI.

Competitor.	Address.	Variety.	Yield 1 point per bus.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total
			50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
Miguel, J. A.	Wialki	Bencubbin	9	9	9	14	13	54
Anderson, T.	Wialki	Bencubbin	7	9	9	14	12	51

Mr. J. A. Miguel's crop of "Bencubbin" was grown on salmon gum-mallee country which had been ploughed in early July, 1937, with a disc plough to a depth of 3 inches. It was springtyne cultivated in early September, 1937, and seeded during the middle of April, when seed and superphosphate were applied at the rate of 30 lbs. and 60 lbs. per acre, respectively.

FERTILISERS.

In accordance with the Fertilisers Act, 1928, the list of fertilisers registered in the present fertiliser year, which commenced on 1st November, 1938, is appended in tabular form.

As a guide to agriculturists in purchasing their manures, the unit values for the different forms of nitrogen, phosphoric acid and potash have been calculated from the retail prices per ton.

The main variations from last year's figures have been an increase of 1s. per unit for nitrogen in blood and bone, bonedust, etc., and for the same class of fertiliser the unit for phosphoric acid shows a rise of 3d. per unit. Ammoniacal nitrogen shows a decrease of 1d. per unit.

The prices of the other fertilisers have remained constant.

These unit values are shown in comparison with those of the previous three years, in the following table:—

UNIT VALUES.

	1935–36.	1936–37.	1937–38.	1938–39.
NITROGEN (N) as—	s. d.	s. d.	s. d.	s. d.
Dried Blood, Blood and Bone, Bonedust, and Bone and Flesh	22 0	21 8	23 0	24 0
Nitrate...	18 3	18 2	18 1	18 1
Ammonia	12 3	11 8	11 3	11 2
PHOSPHORIC ACID (P_2O_5) as—				
Water Soluble as Superphosphate ...	3 5	3 4	3 3	3 3
Citrate Soluble as Superphosphate ...	3 5	3 4	3 3	3 3
In Bonedust, Blood and Bone, and other Animal Fertilisers	5 9	5 6	5 9	6 0
Basic Phosphate	5 1	4 11	4 11	4 11
Acid Soluble in Superphosphate and Rock Phosphate	2 2	2 2	2 2	2 2
POTASH (K_2O) as—				
Sulphate	6 0	6 4	6 5	6 5
Muriate	5 0	5 6	5 7	5 7

FERTILISERS.

The following fertilisers have been registered at the Department of Agriculture under the Fertilisers Act, 1928, for the year commencing 1st November, 1938:—

Name of Fertiliser.	Reg. No.	Brand.	By Whom Registered	Nitrogen (N) as: Nitrate.	Nitrogen (N) as: Ammonia.	Nitrogen (N) as: Blood and Bone	Nitrogen (N) as: Bone-dust.	Phosphoric Acid (P_2O_5) as: Water Sol.	Phosphoric Acid (P_2O_5) as: Citrate Sol.	Phosphoric Acid (P_2O_5) as: Acid Sol.	Phosphoric Acid (P_2O_5) as: Total.	Potash (K_2O) as: Sulphate.	Potash (K_2O) as: Muriate.	Cash Price per ton on Rail at Works or Perth.
				%	%	%	%	%	%	%	%	%	%	
A.—MINERAL.														
1.—NITROGENOUS.														
(a)—Nitrogen as Nitrate.														
Nitrate of Soda	32	Sickle	Cuming Smith & Mt. Lyell F.F. Ltd.	15·50										14 0 0
Do.	59	ML in diamond	do. do.	15 50										14 0 0
Do.	86	CSML	do. do.	15 50										14 0 0
Do.	130	Cresco	Cresco Fertilisers (W A), Ltd	15 50										14 0 0
Do.	138	Champion	A. Hicks	16·00										
(b)—Nitrogen as Ammonia.														
Sulphate of Ammonia	8	ICI	Cuming Smith & Mt. Lyell F.F. Ltd.		20 6									12 5 0
Do. do.	31	Sickle	do. do.		20 50									12 5 0
Do. do.	58	ML in diamond	do. do.		20·50									12 5 0
Do. do.	85	CSML	do. do		20·50									12 5 0
Do. do.	125	Cresco	Cresco Fertilisers (W A). Ltd.		20·50									12 5 0
2.—PHOSPHATIC														
(a)—Rock Phosphate.														
Pacific Islands Phosphate	30	Sickle	Cuming Smith & Mt. Lyell F.F. Ltd.							36·65	36·65			4 0 0
Do. do.	57	ML in diamond	do. do							36·65	36·65			4 0 0
Do. do.	89	CSML	do. do							36·65	36·65			4 0 0
Phosphate Powder	112	Cresco	Cresco Fertilisers (W A.). Ltd							36·65	36·65			4 0 0
(b)—Superphosphates.														
Florida Superphosphate (22%)	9	Sickle	Cuming Smith & Mt. Lyell F.F Ltd.					20·50	·50	1·00	22·00			3 12 6
Do. do. (23%)	10	do.	do do.					21·25	·50	1·25	23·00			3 12 6
22% Superphosphate	36	ML in diamond	do. do.					20·50	·50	1·00	22·00			3 12 6
High Grade Super (23%)	37	do. do.	do. do.					21 25	·50	1·25	23·00			3 12 6
22% Superphosphate	63	CSML	do. do.					20·50	·50	1·00	22·00			3 12 6
High Grade Super (23%)	64	do.	do. do					21·25	·50	1·25	23·00			3 12 6
"23" Super	111	Cresco	Cresco Fertilisers (W.A). Ltd.					21·25	·50	1·25	23·00			3 12 6

(c)—Rock Phosphate and Superphosphate.														
Phosphate Mixture 50/50	29	Sickle	Cuming Smith & Mt. Lyell F.F., Ltd.					10·00	·50	18·50	29·00			4 1 6
Do. do.	56	ML in diamond	do. do.					10 00	50	18·50	29·00			4 1 6
Do. do.	84	CSML	do. do.					10·00	·50	18·50	29·00			4 1 6
50/50 Phosphate	129	Cresco	Cresco Fertilisers (W A), Ltd					10 00	·50	18·50	29·00			4 1 6
(d)—Basic Phosphate.														
Basic Phosphate	28	Sickle	Cuming Smith & Mt. Lyell F F., Ltd							17·00	17·00			4 4 0
Do.	55	ML in diamond	do. do							17·00	17·00			4 4 0
Do.	75	CSML	do. do.							17·00	17·00			4 4 0
3.—POTASSIC.														
(a)—Potash as Sulphate.														
Sulphate of Potash	3	Palestine	Geo Wills & Co., Ltd.									48·60		15 10 0
Do. do.	33	Sickle	Cuming Smith & Mt. Lyell F F Ltd.									48 60		15 10 0
Do. do.	60	ML in diamond	do. do									48·60		15 10 0
Do. do.	87	CSML	do. do									48·60		15 10 0
Do. do.	93	Sun	The Westralian Farmers Ltd.									48·60		15 10 0
Do. do.	124	Cresco	Cresco Fertilisers (W A) Ltd.									48·60		15 10 0
(b)—Potash as Muriate.														
Muriate of Potash	2	Palestine	Geo. Wills & Co , Ltd.										50·00	14 10 0
Do. do.	34	Sickle	Cuming Smith & Mt Lyell F.F , Ltd.										50·00	14 0 0
Do. do.	61	ML in diamond	do. do										50 00	14 0 0
Do. do.	88	CSML	do. do.										50·00	14 0 0
Do. do.	97	Sun	The Westralian Farmers, Ltd.										50·00	14 10 0
Do. do.	131	Cresco	Cresco Fertilisers (W A.), Ltd.										50·50	14 0 0
Kainit	94	Sun	The Westralian Farmers, Ltd										14·00	*
Potash Manure Salts	96	do.	do. do.										30·00	*
4.—NITROGEN AND PHOSPHORIC ACID.														
Super and Ammonia, No. 1	21	Sickle	Cuming Smith & Mt Lyell F.F., Ltd.		2 94			17 57	·43	·85	18 85			5 10 6
Do. do. No. 2	22	do.	do. do.		5·15			15·37	·37	·76	16·50			6 10 0
Do. do. No. 3	23	do.	do. do.		6 00			14 25	·40	1·10	15·75			6 15 0
Do. do. No. 4	24	do.	do do		6·87			13 66	·34	·66	14·66			7 4 0
Do. do. No. 5	25	do	do. do		10 30			10·25	25	·50	11·00			8 14 0
Do. do. No. 1	48	ML in diamond	do. do.		2·94			17 57	43	·85	18·85			5 10 6
Do. do. No. 2	49	do. do.	do. do.		5·15			15 37	·37	·76	16·50			6 10 0
Do. do. No. 3	50	do. do.	do. do.		6·00			14 25	·40	1·10	15·75			6 15 0
Do. do. No. 4	51	do. do.	do. do		6 87			13·66	·34	·66	14·66			7 4 0
Do. do. No. 5	52	do. do.	do. do.		10·30			10·25	·25	·50	11·00			8 14 0

FERTILISERS.—*continued.*

Name of Fertiliser.	Reg. No.	Brand.	By Whom Registered.	Nitrogen (N) as Nitrate.	Nitrogen (N) as Ammonia.	Nitrogen (N) as Blood and Bone.	Nitrogen (N) as Bone-dust.	Phosphoric Acid (P_2O_5) as Water Sol.	Phosphoric Acid (P_2O_5) as Citrate Sol.	Phosphoric Acid (P_2O_5) as Acid Sol.	Phosphoric Acid (P_2O_5) as Total.	Potash (K_2O) as Sulphate.	Potash (K_2O) as Muriate.	Cash Price per ton on Rail at Works or Perth.
				%	%	%	%	%	%	%	%	%	%	£ s. d.
4.—Nitrogen and Phosphoric Acid.—*continued.*														
Super and Ammonia, No. 1	79	CSML	Cuming Smith & Mt Lyell F.F. Ltd.		2·94			17·57	·43	·85	18·85	..	....	5 10 6
Do. do. No. 2	80	do	do. do.		5 15		.	15·37	·37	·76	16·50		...	6 10 0
Do. do. No. 3	81	do.	do. do		6 00	.	..	14·25	·40	1·10	15·75	..	....	6 15 0
Do. do. No. 4	82	do.	do. do.		6 87	.	..	13·66	·34	·66	14·66	...	...	7 4 0
Do. do. No. 5	83	do.	do do.		10 30	..	.	10·25	·25	·50	11·00		...	8 14 0
Phosphate of Ammonia	106	Floraphos	J. A. Newman & Co.		15 60	..		31·20		...	31·20	..	..	35 0 0
Super and Ammonia, 1 : 1	119	Cresco	Cresco Fertilisers (W.A.), Ltd.		10 30	...	..	10·25	·25	·50	11·00	...	...	8 14 0
Do. do. 2 : 1	120	do.	do. do		6·87	...	.	13·66	·34	·66	14·66	....	...	7 4 0
Do. do. 3 : 1	121	do.	do. do.		5·15	.	..	15·37	·37	·76	16·50	..	....	6 10 0
Do. do. 6 : 1	122	do.	do. do		2 94	..	.	17·57	·43	·85	18·85	.	....	5 10 6
5.—Nitrogen, Phosphoric Acid and Potash.														
Potato Manure, "B"	11	Sickle	Cuming Smith & Mt Lyell F.F., Ltd.		3·75	..	...	14·50	·35	·75	15·60	4·50	....	7 2 0
Do. "C"	12	do.	do. do.		3 50	...		16·75	·40	1·10	18·25	...	...	5 16 0
Do. "E"	13	do.	do. do.		3·50	..	.	14·00	·30	·70	15·00	8·00	...	7 19 0
Do. "F"	14	do.	do. do.		6 00	...	..	14·25	·40	1·10	15·75	....	...	6 15 0
Do. "G"	15	do.	do. do.	.	3 50	....	....	10·50	·20	·60	11·30	16·00	....	10 0 0
Do. "H"	16	do.	do. do.	.	4 00	....	..	12·70	·30	·70	13·70	9·00	....	8 8 0
Do. No. 5	17	do.	do. do.		7·50	....	.	7·00	·20	·40	7·60	13·25	....	11 1 0
Orchard Manure	18	do.	do. do.		2 00	..	..	15·75	·40	1·10	17·25	...	5·00	6 6 0
Special Mixture, "K"	19	do.	do. do.		8 34	..	.	8·40	·20	·40	9·00	...	10·04	10 2 6
Do. "KP"	20	do.	do. do.		6·34	...	..	10·50	·20	·80	11·50	10·04	...	9 13 0
Tobacco Fertiliser	27	do.	do. do.	3 30		...	.	14·00	·50	1·00	15·50	5·70	....	7 10 0
Potato Manure, No. 2	38	ML in diamond	do. do.		3 50	..	.	16·75	·40	1·10	18·25	...	...	5 16 0
Do. No. 3	39	do.	do. do.		3·75		...	14·50	·35	·75	15·60	4·50	....	7 2 0
Do. No. 4	40	do.	do. do		3·50		.	14·00	·30	·70	15·00	8·00	...	7 19 0
Do. No. 5	41	do.	do. do.		7 50	..	...	7·00	·20	·40	7·60	13·25	...	11 1 0
Do. No. 6	42	do.	do. do.		6·00		.	14·25	·40	1·10	15·75	....	....	6 15 0
Do. No. 7	43	do.	do. do.		3·50	.	....	10·50	·20	·60	11·30	16·00	...	10 0 0
Do. No. 8	44	do	do. do.		4·00		...	12·70	·30	·70	13·70	9·00	...	8 8 0
Orchard Manure	45	do.	do. do.		2 00		.	15·75	·40	1·10	17·25	....	5·00	6 6 0
Special Mixture, "K"	46	do.	do. do.		8 34	..	..	8·40	·20	·40	9·00	....	10·04	10 2 6
Do. "KP"	47	do.	do. do		6 34	..	..	10·50	·20	·80	11·50	10·04	....	9 13 0
Tobacco Fertiliser	54	do.	do. do.	3·30		..	..	14·00	·50	1·00	15·50	5·70	....	7 10 0
Potato Manure, "B"	65	CSML	do. do.		3·75	....	..	14·50	·35	·75	15·60	4·50	....	7 2 0
Do. "C"	66	do.	do. do		3·50	....	..	16·75	·40	1·10	18·25	....	...	5 16 0
Do. "E"	67	do	do. do.		3·50	...	..	14·00	·30	·70	15·00	8·00	...	7 19 0
Do. "F"	68	do.	do. do.	...	6 00	....	....	14·25	·40	1·10	15·75	....	....	6 15 0

Do. "G"	69	do.	do. do.		3·50			10·50	·20	·60	11·30	16·00	....	10 0 0
Do. "H"	70	do.	do. do.		4·00			12·70	·30	·70	13·70	9·00	....	8 8 0
Do. No. 5	71	do.	do. do.		7·50			7·00	·20	·40	7·60	13·25	....	11 1 0
Tobacco Fertiliser	73	do.	do. do.	3 30				14·00	·50	1·00	15·50	5·70	....	7 10 0
Do. do. No. 2	74	do.	do. do	3 70				13·20	·30	·70	14·20	7·00	....	7 14 0
Orchard Manure	76	do.	do. do		2·00			15·75	·40	1·10	17·25	....	5·00	6 6 0
Special Mixture. "K"	77	do.	do. do.		8·34			8·40	·20	·40	9·00		10·04	10 2 6
Do. "KP"	78	do.	do. do.		6·34			10·50	·20	·80	11·50	10·04	....	9 13 0
Potato Special	113	Cresco	Cresco Fertilisers (W.A.), Ltd.		4·00			12·70	·30	·70	13·70	9·00	....	8 8 0
Special Orchard Manure	114	do.	do. do		8·34			8·40	·20	·40	9·00	....	10·04	10 2 6
Potato Manure	115	do.	do do.		1·50			7·10	1·40	13·50	22·00	7·50	....	6 15 0
Orchard Manure	116	do.	do. do.		1·50			7·10	1·40	13·50	22·00	7·50	....	6 15 0
Mixed Manure	117	do.	do. do		1·50			7 10	1·40	13·50	22·00	7·50	....	6 15 0
Vine Manure	118	do.	do. do.		1·50			7·10	1·40	13·50	22·00	7·50	....	6 15 0
†Special Lawn Manure	132	do.	do do.		6·94			3·95	·23	5·67	9·85	6·02	....	12 0 0
Potato Manure	133	Eclipse	West Australian Meat Exports Coy., Ltd.		3·00			16·00		·25	16·25	4·25		7 10 0
6.—MISCELLANEOUS.														
Super and Manganese *	128	Cresco	Cresco Fertilisers (W.A.), Ltd.					17·00	·50	1 00	18·50			7 10 0
B.—ORGANIC.														
(a)—*Blood and Bone.*														
Animal Fertiliser	1	State Abattoirs, Midland Junction	State Abattoirs, Midland Junction			8 00				5·00	5·00			10 0 0
Blood and Bone	6	Riverstone	Riverstone Meat Co			5·50			5·00	9·25	14·25		....	7 5 0
Do.	35	Sickle	Cuming Smith & Mt Lyell F.F., Ltd			5·00				15·00	15·00			10 0 0
Do.	62	ML in diamond	do. do			5 00				15·00	15·00		....	10 0 0
Do.	91	CSML	do. do.			5·00				15·00	15·00			10 10 0
Do. "G"	92	do.	do. do.			6·00				12·00	12·00			10 10 0
Do.	95	Sun	The Westralian Farmers, Ltd.			5·25					14·00			8 15 0
Do.	99	Wyndham	Wyndham Freezing, Canning & Meat Export Works			6·00			6·00	6 50	12·50			9 12 6
Do.	101	A.N.A Surprise	C. A. Kirkby & Son			5·00			4·00	10·00	14·00			10 10 0
Do.	105	Apollo	Soap Distributors, Ltd.			7·00					14·00			10 7 6
Do.	127	Cresco	Cresco Fertilisers (W.A.), Ltd.			5 25				14·00	14·00			10 10 0
Do.	109	A1 in circle	Haynes & Clements			5 25			3·00	9·00	12·00			11 5 0
Do.	110	Albany Freezing Works, Limited	Albany Freezing Works, Ltd.			6·00					12·00			9 10 0
Do.	135	Eclipse	West Australian Meat Exports Coy., Ltd			6·00					12·00		....	10 0 0
Do.	137	"Robbs"	do. do.			5·25					14·00		....	9 15 0
Do.	139	Cockbills	Harrold & Murray			5·25			3·00	9·00	12·00			7 15 0
Do.	140	KBM	R. Bates			5·00				9·00	9·00		....	8 10 0
(b)—*Bones.*														
Bonedust	90	CSML	Cuming Smith & Mt. Lyell F.F., Ltd.				3 50			22·00	22 00			11 0 0
Do.	126	Cresco	Cresco Fertilisers (W.A.), Ltd.				3 50			22·00	22·00			11 0 0

† Contains traces of Magnesium, Iron, Copper, Zinc and Manganese as Sulphate.

* Contains 5·75% Manganese as (MnO_2).

FERTILISERS.—*continued.*

Name of Fertiliser.	Reg. No.	Brand	By Whom Registered	Nitrogen (N) as				Phosphoric Acid (P_2O_5) as				Potash (K_2O) as		Cash Price per ton on Rail at Works or Perth.
				Nitrate	Ammonia.	Blood and Bone	Bonedust.	Water Sol.	Citrate Sol.	Acid Sol.	Total.	Sulphate.	Muriate.	
B.—ORGANIC.—*continued.* (*b*) *Bones*—continued.				%	%	%	%	%	%	%	%	%	%	£ s. d.
Bonedust	136	Eclipse	West Australian Meat Exports Coy., Ltd				3 50			22 00	22 00			7 10 0
Do.	141	KBM	R. Bates				3·00			18·00	18 00			6 15 0
(*c*)—*Fish Fertiliser*	107	Cormo	M. F. Phillips			7 00					8 00			*
(*d*)—*Blood.*														
Dried Blood ...	5	Imperial	W. Angliss & Co Pty. Ltd			12·0 (as dried blood)								15 10 0
Do. ..	7	Riverstone	Riverstone Meat Co. Pty., Ltd.			13·0 (as dried blood)								13 10 0
C.—MINERAL AND ORGANIC.														
Manurial Insecticide	4	Kill-A-Mite	Kill-A-Mite Co.				2·02				3·76		2·51	*
Bone and Super	26	Sickle	Cuming Smith Mt Lyell F.F. Ltd.			2·00		13·00	·80	4·70	18·50		...	6 17 6
Do.	53	ML in diamond	do. do			2 00		13·00	80	4 70	18·50			6 17 6
Do.	72	CSML	do. do			2·00		13 00	·80	4·70	18 50			6 17 6
Fe tos	98	Floreat	T. S. McGill		9 38			15 00	·50	1·55	17·05		...	20 0 0
Domestic Garden, No. 1	100	Wondergrowth	W. J. Mathews		3 75			12·00	·30	3·20	15·50			*
†Special Mixture for Lawns	101	Sickle	Cuming Smith Mt Lyell F F., Ltd		6 94			3·95	·23	5·67	9 85	6·02	...	12 0 0
† Do. do. do.	102	ML in diamond	do. do.		6 94			3 95	·23	5·67	9·85	6·02	..	12 0 0
† Do. do. do.	103	CSML	do. do.		6 94			3·95	·23	5·67	9·85	6·02		12 0 0
Bone, Super and Potash	123	Cresco	Cresco Fertilisers (W A.), Ltd.				1·00	.		14·00	14·00	1·00		4 17 6
Phosphoric Guano	108	Cormo	M. F. Phillips				2·2				23·89		...	5 2 6
B.S.P. ..	134	Eclipse	W. A. Meat Exports Coy Ltd	.	1·2‡			5·00	.	9 00	14 00		1·20	5 0 0

* Price on application. † Contains traces of Magnesium, Iron, Copper, Zinc and Manganese as Sulphate. ‡ Part Bonedust

OAT, WHEAT, AND BARLEY VARIETY TRIALS IN THE DAIRYING DISTRICTS.

H. G. ELLIOTT, Agrostologist.

Resumé of the results to date of these Trails conducted throughout the South-West Dairy Belt during the 1937 *and* 1938 *Seasons.*

These trials have been conducted for a number of years by officers of the Dairy Branch. During the season 1938 Atlas Barley was introduced for the first time and the wheat varieties deleted.

The objects of the trials are as follows:—

To determine which variety of oats, if any, gives higher yields of hay per acre than the variety "Algerian."

To determine if barley or wheat would give greater yields than the oat varieties.

Ferti'iser:—In every case 1 bag (180 lbs.) of superphosphate was applied per acre.

Rate of Seeding:—2 bushels per acre for oats; 1⅓ bushels per acre for wheat and barley.

Method:—Each variety was sown in plots of half acre and in triplicate.

The following Table I. gives the results:—

——	Algerian Oats	Guyra Oats.	Mulga Oats.	Burts Early Oats	Wongan Oats	Nabawa Wheat	Yandilla King Wheat	Atlas Barley.
J. Johnson, Harvey—								
Tons, acre	2 45	2 49		2 45	2 47	1 60	1 77	
% Yield	100	102		100	102	65	72	
J. Rae, Yarloop—								
Tons, acre	0 86	1·07	0 92	0 86	0 80	1·31	1 10	
% Yield	100	124	107	100	93	152	128	
E. Lloyd, Denmark—								
Tons, acre	2 40		2 70	2·20	2 60	2 40	0·88	
% Yield	100		113	92	108	100	37	
R. J. Trigwell, Donnybrook—								
Tons, acre	2 33	2 28	1 46	1 42	0 97	1 22	1 26	
% Yield	100	98	63	61	41	52	54	
H. J. Blowfield, Harvey—								
Tons, acre	2 87		2·69	2 36	2 10			1 95
% Yield	100		94	82	73			68
J. A. Lynam, Bridgetown—								
Tons, acre	2·02		2·11	2·20	2 56			2·43
% Yield ...	100		104	113	127			120
Coley Bros., Vasse—								
Tons, acre ...	0·82		0 60	0·55	0·55			
% Yield	100		73	66	66			
J. Salarian, Waroona—								
Tons, acre	4·91		3 71	3 95	3·47			4·68
% Yield	100		76	80	71			95·3

(Hay Yields estimated.)

J. Johnson, Harvey.

Information supplied by A. M. Tindale, Dairy Instructor. The varieties were sown on 20-21st May, 1937, on well-drained red loam which was originally

timbered by redgum and jarrah. The land was disc ploughed and cultivated twice with the spading harrows prior to seeding. The rainfall during the growing period was 24 inches. The weights were taken on 26th October, 1937.

J. Rae, Yarloop.

A. M. Tindale, Dairy Instructor.

Plots were sown on 22nd and 23rd May, 1937, on grey sandy clay. The land was ploughed with a mouldboard plough and the seed harrowed in. The rainfall during the growing period was 24½ inches. The wheat in all plots showed better and stronger growth than the oats.

The soil dried out very early and was somewhat waterlogged during the winter months. The whole area was generally uneven and a poor stand.

The weights were taken on 17th and 18th November, 1937.

R. J. Trigwell, Donnybrook.

M. Cullity, Senior Agricultural Adviser.

Plots sown on a hillside with a northern aspect on a soil which varied from a greyish to brown clayey loam. Seeding was carried out on the 27th July on a well-worked seed bed.

The plots were cut as under: Nabawa, Burts Early, Mulga and Wongan on 12th November, 1937; and Guyra, Algerian, and Yandilla King on 29th November. Weighings were made from the stooks on the 24th November and 13th December.

H. J. Blowfield, Harvey.

G. Gauntlett, Agricultural Adviser.

Plots sown on red clayey loam on the 29th June, 1938. The rainfall during the growing period was 23½ inches.

The variey "Algerian" was the most outstanding but was much later in coming away than the others. "Mulga" made excellent growth during the winter months and is probably the best allround variety.

With the exception of "Algerian" all varieties of oats were attacked by leaf and stem rust, "Wongan" being most severely affected.

J. A. Lynam, Bridgetown.

A. M. Tindale, Dairy Instructor.

The seed was sown on red loam which was originally timbered with jarrah and redgum and which had been under subterranean clover for a number of years.

The land was ploughed on 19th May and harrowed twice. The seed and fertiliser were drilled in on 23rd May, 1938.

The rainfall during the growing period was 20½ inches.

All varieties came away well, "Wongan" varieties of oats and the barley being ahead of the others.

Coley Bros., Vasse.

J. M. Nelson, Dairy Supervisor.

The varieties were sown on a red sandy loam which was originally timbered with redgum, jarrah and a little blackbutt. The land was cropped the previous season with potatoes which were fertilised with 15 cwts. "B" potato manure per acre.

Excellent cultivation was carried out, the land being ploughed 4 inches, double disced, rolled, tyne harrowed and the seed and fertiliser drilled in with a disc drill on 30th and 31st May.

The results were very disappointing, due mainly to a root rot disease which was evident from the time the crop was 8 inches high.

J. Salarian, Waroona.

T. Lutz, Agricultural Adviser.

The trial was planted on 11th June on well worked seedbed with a disc drill, the soil being a dark chocolate loam which was originally timbered with redgum. The land was cropped to potatoes the previous season. The rainfall during the growing period was 22.8 inches.

The average yield for all varities is shown in the following Table 2.

Variety.	No. of Trials.	Hay. Tons/ac.	% Yield.
Oats—			
Algerian	8	2.33	100.0
Mulga	7	2.02	86.7
Burts Early	8	2.01	86.2
Guyra	3	1.95	83.7
Wongan	8	1.94	83.2
Wheat—			
Nabawa	4	1.63	70.0
Yandilla King	4	1.25	53.7
Barley—			
Atlas	3	3.02	129.6

These trials will be conducted again this season.

"THE JOURNAL OF AGRICULTURE"

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IRRIGATED PASTURE COMPETITION.

RESULTS OF SECOND YEAR'S INSPECTIONS—1938.

H. G. ELLIOTT, Agrostologist.

A. R. C. CLIFTON, Officer in Charge of Irrigation.

The above competition was inaugurated by the Harvey Agricultural Society in 1937, and a resumé of the results of the first year's inspections, 1937, was given in the March, 1938, issue of this Journal.

This competition embraces the whole of the irrigation areas extending from Waroona to Dardanup. The Agricultural Societies of Waroona, Harvey and Brunswick, together with the Waterloo P.P.A., also run individual annual competitions embracing the entries from their respective districts.

In the main competition the pastures are to be judged yearly for a period of three years, and the competitor gaining the highest total number of points for all inspections will be judged the winner.

Messrs. Cuming Smith & Mt. Lyell Farmers' Fertilisers, Ltd., have generously donated a trophy valued at 10 guineas for the winner at the conclusion of the competition. The Societies also award an annual prize for the winners in their area.

The results of the 1938 inspections, which were carried out during the months of June and December, have been combined and the results are given in the following table: —

TABLE I

Competitor	Drainage and Irrigation Layout and Condition.	Mixture.	Sward Uniformity.	Condition of Pasture according to age.	Management.	Total.
	20	20	20	20	20	100
J. Salarian, No 2, Waroona	18	18	17½	17	16½	87
D. Moore (A. E. Jackson), Brunswick	16½	17½	16	13	14	77
C. E. Edwards, No 1, Waterloo	16½	17½	13	13	16½	76½
J. Salarian, No 1, Waroona	15½	16½	14½	15½	13½	75½
E. Holthouse, No. 2, Harvey	17	16½	16	11	12	72½
L. Temple, No. 2, Harvey ...	14½	16½	14	15	12	72
L. Temple, No 1, Harvey	14½	16½	13½	15	12	71½
E. Holthouse, No 1, Harvey	16½	17	14½	11½	12	71½
S. Bowers, Brunswick	16½	16	11½	11½	12½	68
C. E. Edwards, No. 2, Waterloo	16	15	11½	11½	13	67
C. F. Giblett, Harvey	15½	13½	13	10	12½	64½
W. C. Edwards, Burekup	14	12	10½	10	15	61½
H. Piggot, Brunswick	16	14	12½	7	10½	60
F. Reeves, Brunswick	15	12½	11	8½	11½	58½
T. P. Harris, Waterloo	13½	12	9½	10	12	57
L. & C. Hynes, No. 1 Waterloo	14½	12	10½	6½	11	54½
L. & C. Hynes, No. 2 Waterloo	14½	12	11	6½	10½	54½
T. Tyrell, Waterloo	13	10½	9½	9	11½	53½
J. J. Hynes, Waterloo	14	11½	10	6	8½	50

Note.—F. H. Beecher, Harvey and W. Noakes, Brunswick, both withdrew.

The winners of the annual prizes awarded by the Societies conducting the competition are as follow:—

Waroona Agricultural Society ..	J. Salarian's No. 2 entry.
Brunswick Agricultural Society ..	A. E. Jackson (D. Moore).
Harvey Agricultural Society ..	E. Holthouse's No. 2 entry.
Waterloo P.P.A.	C. E. Edwards' No. 3 entry.

Additional entries were received in the Waroona and Waterloo areas for the annual competition.

From the above table it will be seen that Mr. J. Salarian, Waroona, gained the highest for the two inspections during the second year. The pasture exhibited consisted of White Clover, Perennial Ryegrass and Cocksfoot as the dominant species. Subterranean Clover, Lotus Major and Yorkshire Fog were present as minor constituents, and couch grass occurred in small isolated patches.

This field has been rotationally grazed throughout, the intervals between grazing varying from 14 to 24 days according to the season and growth recovery of the pasture species. The method of grazing which is being practised by this farmer is highly commended, but it is suggested that the periods between grazing of this type of pasture should not be less than 18-21 days. Some authorities are of the opinion that even a longer period between grazing would be advantageous, but until further information on this subject, under existing conditions, is obtained, present indications show that approximately 21 days is giving the most economical results from a grazing point of view.

The renovation carried out on the winning pasture during June of last year was severe, but resulted soon after in phenomenal vigour and production of the pasture. With the exception of one or two small patches of dodder, practically no weeds could be found over the area. It is considered that, with an efficient system of winter renovation, dodder can be eventually controlled.

Table II. gives the results of the four inspections, 1937 and 1938.

TABLE II.

Competitor.	1st Inspn. 1937.	2nd Inspn. 1937.	3rd Inspn. 1938	4th Inspn. 1938.	Total.
J. Salarian, No. 2	70	71	87	87	315
C. E. Edwards, No. 1	78	82	79	74	313
D. Moore (A. E. Jackson)	64	73½	78	76	291½
E. Holthouse, No. 2	69½	75	72	73	289½
J. Salarian, No. 1	69	60	72	79	280
L. Temple, No. 1	73½	62	76	67	278½
L. Temple, No. 2	73	61	76	68	278
C. E. Edwards, No. 2	64	76	71	63	274
E. Holthouse, No. 1	71	50	68	75	264
S. Bowers	60	59	68	68	255
T. P. Harris	55	77½	54	60	246½
F. Reeves	63	61	58	59	241
C. F. Giblett	57	47½	64	65	233½
H. Piggot	49½	56½	53	67	226
W. C. Edwards	47	51½	58	66	223½
T. Tyrell	55	51½	59	48	213½
L. & C. Hynes, No. 2	59½	50½	50	59	209
L. & C. Hynes, No. 1	53	45	50	59	207
J. Hynes	50½	45½	50	50	196

This table shows that Mr. Salarian's No. 2 entry is now leading by two points from that of Mr. C. E. Edwards' No. 1 entry. At the time of the last inspection, 1938, Mr. Edwards' entry was showing a considerable amount of scalding, due to insufficiency of attention during the watering operations. The pasture consists of Perennial Ryegrass and White Clover, with an excellent ground cover. The

sward was very even, this being due to the area being cut for hay some three weeks prior to inspection.

The results of the second year's inspections showed that:—

Generally, the management of the irrigated pastures has been neglected, more particularly with reference to grazing, this being due, to a great extent, to the phenomenal growth of annual pastures which occurred during the spring months. Many of the competitors had left their irrigated pastures for hay and consequently, when the first application of water should have been given, hay was still on the ground. This meant a considerable opening up of the sward by the killing off of a number of the perennial species, particularly the White Clover. If a farmer intends to cope with the prolific spring growth of his annual pastures by grazing, the irrigated fields should not be left for hay cutting, but should be cut early for silage. This operation would overcome the opening up of the pasture, prevent the entry of weeds and assist in checking the couch grass spread—all of which, if allowed, increase at the expense of the more valuable perennial pastures species.

The layouts generally were unaltered since the previous inspections, with the exception of the head ditches. In the majority of cases at the second inspection, 1938, they were foul with weeds and unfit to be used, although attempts had been made to water some of the competition pastures without first reconditioning the ditches since the last irrigation season. This condition meant further points lost in the management section, owing to scalding, apparently due to the condition of the head ditches being such that a full head of water could not be used or properly controlled.

Fertilisers:—Suitable fertiliser for pastures is required not only to produce a high yield of green material, but to ensure it having a maximum feeding value. Phosphate is the manurial constituent mainly required. The fertiliser rates per acre used by the competitors varied from 3-7 cwts. per annum, applied in 2 to 4 applications. Superphosphate is the principal fertiliser applied, but in odd instances small quantities of sulphate of ammonia and potassic fertilisers have been used.

Weeds:—The main weeds encountered were the various types of rushes, particularly in the Brunswick-Waterloo area. It is unfortunate that many irrigated pasture fields are infested with these rushes, and also that this infestation has extended during the last few seasons. Rushes are, generally speaking, moisture and acid loving weeds, which do not thrive on well drained and properly managed pastures. The most efficient method of control is to drain the land efficiently where required, cut the rushes close in April followed by efficient topdressing with superphosphate; in November and the following April cut and fertilise again. It is essential that cutting should not be later than November to prevent seed formation. The pest is rapidly spread by means of seed. Couch grass is also a problem on many areas. If the pasture is heavily grazed, fertilised and efficiently renovated in May, much will be accomplished to stimulate the White Clover and suppress the couch grass spread.

Renovation:—Although surface harrowing to spread animal droppings was carried out in most instances, it was generally insufficient as uneven swards and a considerable amount of wastage were observed during the last inspection. Many competitors are topping their pastures, and having once carried out this practice will continue to do so, as the benefits are most marked.

Drainage:—It must be remembered that it is more or less futile to attempt to improve irrigated pasture by manuring if the soil is in need of drainage, and unfortunately many of the irrigated pastures judged were in need of more ade-

quate drainage. Drainage is essential for permanent pasture production. Waterlogged soils generally produce pastures of poor quality—moreover it is almost impossible to suppress the growth of rushes if the pastures are winter waterlogged.

Even though a thorough system of drainage may not be possible, much improvement can be effected by the cleaning out of existing drains and by keeping drain outfalls clear, so that the drainage water is allowed to run away freely.

Uneven Swards:—In many pastures the ryegrass has developed perched crowns, this being due to two main factors:—

(1) Lack of efficient surface drainage.

(2) Insufficiency of soil consolidation prior to seeding.

These perched crowns are liable to severe damage during grazing and the plants are rendered liable to heat and wind damage during the summer months particularly when heavy grazing occurs.

Only good watering methods associated with good layout and adequate drainage, renovation and liberal fertilising, will ensure a persistently high production and an attractive appearance of an irrigated pasture.

LAMB MARKING.

CARE AND CLEANLINESS ESSENTIAL.

By HUGH McCALLUM,
Sheep and Wool Inspector.

Although lamb marking is a routine which the farmer has carried out year after year, and that the procedure is generally recognised as having an important bearing on the health and early development of the lamb, there still appears to be a casualness on the part of some farmers while this phase of the management is being carried out. It is of paramount importance in the nurturing of lambs to see that all the conditions favouring an early start are supplied, so that the lambs' propensities towards growth rate, growth of quality wool and other breed characteristics may obtain maximum expression.

One of these conditions, of course, is a method of marking that will minimise shock, bleeding, infection, bruising and mismothering, all of which cause a set-back to the lamb. To do this the marking is best carried out on a cool, dry morning and the lambs should be rested. The operation is extremely trying to the lambs in cold, wet weather, numbers often dying. The question of age is usually left to the discretion of the farmer and varies from three to five weeks.

Cleanliness, that is in the bacteriological sense, is essential to prevent the wounds becoming septic and the contraction of tetanus (lock-jaw). As a preventive measure a disinfectant should be spread on the ground and points of contact such as rails, etc., and the earmarkers and knives kept in a disinfectant immediately before and between operations. The order of the operation is—1, ear-marking; 2, castrating; 3, tail-docking.

The catcher should be quick but gentle in catching and handling the lambs. He should hold the legs firmly, but not too tightly and let the rump of the lamb rest on the yard rail with its back resting on his chest. On no account should the legs be pulled too far apart, as it often injures the limbs.

After ear-marking, the operator takes the tip of the scrotum between his first finger and thumb of the left hand and using the knife in his right, cuts off

about half an inch of the tip, sufficient to allow the testes to be gently squeezed out with the fingers and thumb and grasped by the teeth. They should be drawn out together as gently as possible without biting or breaking them. With practice the work becomes easy and can be done very rapidly. If a testicle does not come down, do not waste time bruising the organs, but leave that lamb undocked, so that it may readily be recognised later, when the operation can be completed or the lamb killed.

The quarters and cuts should be swabbed with a suitable disinfectant, care being taken to prevent its entry into the purse, as it delays healing.

Although the tailing process is simple, many unsightly tails are still prevalent on some farms. The second joint of the tail vertebrae is found by pressing with the thumb and forefinger of the left hand, the skin being pushed over it towards the rump so that when a clean incision is made through the joint, the end of the bone is not protruding, but covered by the skin that slips back over it. After swabbing the tail, the lamb should be released so that it drops on all four feet, not on its rump, as this may cause immediate contamination of the wounds and is a strain on the limbs.

After marking is completed, the flock should be kept well in hand to see that all the lambs are mothered. One advantage of marking in the morning is that the lambs have the rest of the day to find their mothers, whereas if they were left until night they may not find their mothers and severe losses might be incurred, especially if the night is cold and damp. The lambing percentage may be ascertained by counting the tails.

THE BLOWFLY MENACE.

By HUGH MCCALLUM,
Sheep and Wool Inspector.

Every sheep farmer is undoubtedly aware of the enormous economic losses due to the ravages of the blowfly. Under many farm conditions some losses cannot be avoided, but in most cases these are far too large, and it should be the object of every farmer to minimise these as far as is possible. It appears that mortalities have been on the increase owing to the greater wool production of sheep and the consequent increase in yolk and foreign matter in the wool, thus offering an added attraction for the fly. If the above is so, our methods of dealing with this pest must correspondingly increase in efficiency.

SIGNS OF STRIKE.

It is an easy matter to tell when sheep are struck by just standing off and watching them for a short time. Here and there they will be seen rubbing themselves in the same way as they do for lice; stamping, trying to reach their hindquarters with their mouths; and in the case of rams struck on the belly, trying to scratch themselves with their hooves. In many cases the maggots may not be visible, but on parting the wool they will easily be seen, and on clipping the wool a raw patch may be revealed where the maggots have broken the skin.

PREVENTION OF STRIKE.

Rigid sanitation will greatly facilitate the eradication of the blowfly and it is imperative that the farmer should attend to all necessary details. The carcases of dead animals and the entrails, etc., of slaughtered sheep should be disposed of,

preferably by burning, but if this is not practicable, by burying deeply. The skins should be stretched out to dry in the desired manner as sweating skins bundled together afford a good breeding ground. Blowfly traps are useful if placed where flies accumulate, *e.g.* the killing shed. Rams should be inspected before mating with the ewes, as if struck they may convey the maggots to the latter when serving.

It is generally recognised that plain bodied sheep are much less susceptible to attack than wrinkled ones; it is of advantage, therefore, to cull all badly wrinkled sheep, particularly those with wrinkles around the tail, down the thighs and over the rump.

Crutching is an essential operation and very useful in lowering the percentage of "strike," and should be carried out at definite periods according to the particular conditions of the farm. Crutching removes stained and daggy wool from the breech which is attractive to the fly; usually a repellent is rubbed over this area after crutching.

Mules' Operation.—This consists of removing the folds of skin which are an inducement for "strike." The operation can be carried out on lambs as early as three weeks old and on the healing of the skin the animal appears plain bodied. This, however, must be recognised as only a temporary measure of control as these apparently plain-bodied sheep may throw wrinkly progeny which will require treatment. Culling, therefore, as mentioned previously, is a good practice.

Dipping at the correct time also has a beneficial influence in preventing attack as the wool retains some of the dip.

Jetting. This method is carried out by spraying the wool with a fly repellent through fine nozzles. Experimental work in the Eastern States shows that this control measure gives satisfactory results. A suitable solution is one containing Calcium Arsenite.

There are many useful preparations sold by stock firms with directions for applying. One suitable preparation is composed of glycerine and boric acid in the proportions of 1 gallon of glycerine to 3 lbs. of powdered boric acid, which, when stirred and heated, forms various borates of glycerine which can be kept in stoppered bottles ready for use. This kills the maggots, induces the healing of the skin, and is an excellent measure to prevent "re-strike."

AN INVESTIGATION OF THE WASTAGE IN EXPORT LAMBS DUE TO DELAYED SLAUGHTER.

F. L. SHIER,
Export Lamb Adviser.

A question of considerable importance to the lamb industry, particularly in view of the large extent of the lamb-raising belt in this State, and the distances of many of the producing areas from the export treatment works, is the wastage of lambs due to the time in transit from the farm to the meat works.

Some information is available* which indicates that there is a live weight loss of approximately 5 lbs. between the farm weight when the lambs are removed from their mothers, and the pre-slaughter weight at the works after an interval of 24 to 30 hours. There is, however, no experimental data regarding carcase loss, or the effect on carcase quality as a result of the time lag between the farm and the

*Lambs for Export—Sutton, Thomas, Davenport, Jnl. Dept. Agric., W.A., Vol. 11: 355, 1934.

works. Amongst the farmers it has been frequently stated that the carcase loss is in the order of 2-3 lbs. in the first day. This impression has probably been gained from the fact that the carcase weight is approximately half that of the live weight, and the live weight loss in the first 24 hours is about 5 lbs.

It is possible, however, that all or most of this early live weight loss may simply be due to the voiding of excreta and the actual carcase losses very small indeed. An experiment designed to obtain data on this question was carried out during the 1938 season with lambs from the Avondale Research Station. This experiment is described and discussed in the present paper.

DETAILS OF THE EXPERIMENT.

From the main flock of lambs (Border Leicester-Merino x Southdown) an even line of 120, about 50 lbs. live weight, were ear-tagged on 21/7/38. On 22/8/38 the 120 lambs were weighed and four even groups, each of 20, were random selected. Each group was wool branded with an appropriate mark for ease of drafting at the export treatment works. The 80 lambs were then transported to the Robb's Jetty works by motor truck. The work of mustering, weighing, grouping and transport on 22/8/38 was carried out as quickly as possible, the first group being slaughtered 8 hours after mustering commenced. Group 2 was slaughtered 32 hours after mustering; Group 3, 56 hours; and Group 4, 77 hours. The lambs received no feed or water after leaving the paddock at the farm. The following details were obtained—individual, farm weights, pre-slaughter and carcase weights and grade. The carcases were forwarded to London and a report was furnished by the Head Salesman of Messrs. Sheed, Thomson & Co., Ltd., on the quality of each group.

Results -

The mean figures of each weighing, together with the range, are given in lbs. in Table 1 hereunder:—

TABLE 1.

Group.	Hours after Mustering Slaughtered.	Weight at Avondale.	Pre-slaughter Weight.	Loss from Avondale to Pre-slaughter.	Carcase Weight.		Loss from Farm to Hooks percent.	
					Robb's Jetty.	London.	Robb's Jetty.	London.
1	8	67·4	64·7	2·7	32·6	32·7	51·6	51·5
Range	..	(63–72)	(60–69)	...	(30–36)	...	...	...
2	32	66·7	61·5	5·2	31·9	32·2	52·2	51·7
Range	...	(63–71)	(56–65)	...	(29–35)	...	...	...
3	56	67·2	60·8	6·4	31·5	31·8	53·1	52·7
Range	...	(63–72)	(57–64)	...	(29–35)	...	...	...
4	77	67·3	58·2	9·1	31·0	31·1	53·9	53·8
Range	...	(63–72)	(54–62)	...	(29–35)	...	...	...

The London weights are included as well as those from Robbs Jetty, as it is felt that the average of these two would level out any slight inaccuracies of weighing, and also at the abattoirs the lambs are weighed "hot" immediately after dressing, but with the scales adjusted to deduct an allowance of 4 per cent. The London weight is, of course, the weight of the cold carcase. It is obvious from these two sets of figures that the London weight is similar to the abattoirs weight where the automatic deduction is made.

Grading—

A summary of the grading is given in Table 2 (number of carcases):—

TABLE 2.

Group.	Firsts.	Seconds.	Thirds.
1	18	2	..
2	15	3*	2
3	16	4	..
4	13	5†	2

* 1 carcase graded 2nd on account of colour.
† 3 carcases graded 2nd on account of colour.

London Report—

The relevant sections of the report of the Head Salesman read as follows:—

> Taking each group as a whole, there was practically no difference as regards wastage—there was not any waste fat on the back of the loin. nor did they have wastefully fat kidney knobs, or wastefully fat shoulders; in fact, some in each 20 lot were rather thin for First Quality lambs (Blue Gum).
>
> As regards bloom—there was no difference whatever in each group in colour or bloom.
>
> *Sappiness.*—Again, there was no difference as regards sappiness, or what we (in Smithfield) should term "colour in bone"—*i.e.* blue-boned; they were all blue-boned lambs.

Discussion—

An examination of Table 1 shows that there is an average loss in live weight of approximately 2¾ lbs. in the first eight hours after the lambs are removed from their mothers, increasing up to 9 lbs. after 77 hours. It is quite apparent, however, that this loss is largely excreta, as the average carcase weight of Group 4, killed 69 hours after Group 1, was only 1.6 lbs. lighter than that of the latter. The average carcase weights, as shown in columns 5 and 6, would appear to indicate that there is an average loss in carcase weight of approximately ½ lb. per day when slaughter is delayed up to three days. However, when the individual figures are examined statistically, even in the extreme case of Groups 1 and 4, the average differences are not significant.

Grading and Quality—

The grading returns do not show any significant difference between the groups, although three carcases in Group 4 and one in Group 2 were graded down to second-grade owing to colour. It is not possible to say whether this condition has been brought about by the long period of starvation. The London report is somewhat sketchy, but indicates that the delayed slaughter had no detrimental effect on the bloom and sappiness of the carcases.

Summary—

An experiment is described in which 80 Border Leicester-Merino x Southdown sucker lambs were divided in four groups and killed at 8, 32, 56 and 77 hours after removal from their mothers.

The average loss in live weight rose from 2¾ lbs. at 8 hours to 9 lbs. after 77 hours, but it was evident that this loss was largely excreta, since there were no significant differences in carcase weight or quality between the groups. There was, however, an apparent average daily loss of approximately half a pound. Further work on this aspect is proposed for the coming season.

Acknowledgment is made to the Manager (Mr. W. L. Morgan) of the W.A. Meat Export Co., Robbs Jetty, for permission to obtain the individual details and to the assistance rendered by the officers of the company.

PASTURE DEVELOPMENT.

THIRD YEAR'S RESULTS OF SPECIES TRIALS UNDER CONTROLLED METHODS OF GRAZING IN IRRIGATED AREAS.

H. G. ELLIOTT, Agrostologist.

During the last four years the Australian Dairy Council has made available funds for the conduction of a number of experiments designed to increase and improve pasture production in Western Australia. The Dairy Council has now been merged with the Australian Dairy Board, which body has continued the work previously started and has made increased funds available for further investigations. The experimental work is controlled by a West Australian Pasture Improvement Committee working in close co-operation with the Department of Agriculture.

The following article gives a resumé of information which has been obtained from two experiments at Hamel and Waroona.

C. H. Henning, Hamel.

The information with reference to soil, cultivation, method of seeding, etc., which were carried out on this area is given in the March 1937 issue of this Journal.

The objects of the experiment are—

1. To determine the most suitable grass species in association with white clover for the establishment of permanent pasture under irrigated conditions on the soil type selected in this irrigation area.
2. The collection of information regarding the carrying capacity of these pastures on small irrigated areas.
3. To determine the yields per acre of green material from the various mixtures under existing conditions.

The total area now under pasture has been increased from 8.25 to 10.05 acres, a full year's grazing having been obtained from the new area—Field No. 5.

Irrigation.

During the past season four waterings were given, the dates being 7th January, 11th February, 1st and 25th December.

Fertiliser.

Three applications were given during the season, the first on 2nd February at the rate of 212 lbs., superphosphate per acre, the second on 12th September at 112 lbs., and the third on 14th November also at the rate of 112 lbs. per acre, making a total of 448 lbs. superphosphate per acre for the year. During the first year 4 cwts. per acre were applied in two applications and in the second year 4½ cwts. per acre also in two applications.

The result of the First and Second Year's operations were published in the March, 1937, and 1938, issues of this *Journal*.

Cultivation.

On 27th July the whole area was completely renovated with a rotary prong type of renovator followed by a zig-zag and chain harrow combination. A thorough aeration combined with the breaking up of the cattle droppings was obtained.

On 19th August the irrigation furrows were cleaned out with a "Sunbuster" plough which had been modified slightly. The spoil from the plough was broken down efficiently with a disc cultivator and T-bar roller.

On 25th July rushes which were accumulating mainly in the irrigation furrows were slashed, and on 10th November the majority of them were grubbed out, and at the present time the whole area is free from this pest.

Drainage.

This was improved considerably during the season and at no time were the plots too wet for grazing.

Seed Mixtures.

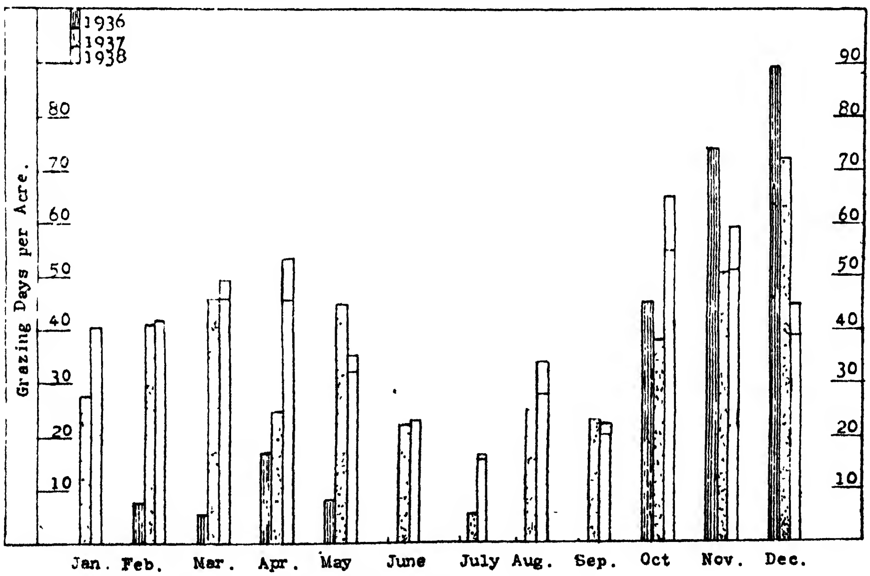
The seed mixtures sown were as follow. In each case certified New Zealand white clover at the rate of 2 lbs. per acre was incorporated:—

Field No. 1.	N.Z. certified mother strain perennial rye grass	8 lbs. per acre.
Field No. 2.	N.Z. certified akaroa cocksfoot	10 lbs. per acre.
Field No. 3.	Certified Phalaris tuberosa	4 lbs. per acre.
Field No. 4.	N.Z. tall fescue	8 lbs. per acre.
Field No. 5.	Paspalum	4 lbs. per acre.

Grazing.

The following Graph No. 1 shows the "Grazing Days per Acre" obtained per month from each field for the past three years.

Graph 1.—Cow Grazing Days per acre.



Graph showing Grazing Days (8 hours) per acre. Note lower line on 1938 column gives grazing days per acre obtained for all fields 1 to 5.

Carrying capacity—8.25 acres 1936 = 1 cow to 1.46 acres.
8.25 acres 1937 = 1 cow to 0.84 acres.
8.25 acres 1938 = 1 cow to 0.73 acres.
10.05 acres 1938 = 1 cow to 0.83 acres.

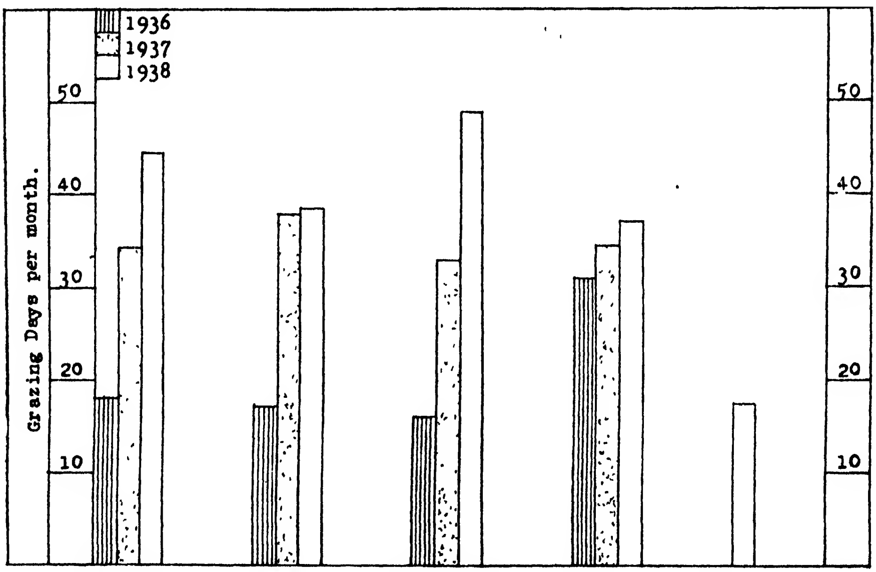
Total Grazing 1938—
32,957 grazing hours from 8.25 acres = 3,990 grazing hours per acre
= 499 grazing days per acre.
35,430 grazing hours from 10.05 acres = 3,522 grazing hours per acre
= 440 grazing days per acre.

From the above graph it will be seen that the grazing obtained for the winter months has shown a decided improvement over that of the last two seasons. As was the case for the previous year, July was the month when the least amount of grazing was obtained, being 17.1 grazing days per month against 5.0 for the previous year.

The following Graph No 2 shows the "Average Grazing Days per Month" for the twelve months of each year 1936, 1937, and 1938 for the various grass species in association with white clover:—

Graph 2.

Cow Grazing Days (8 hours) per acre.



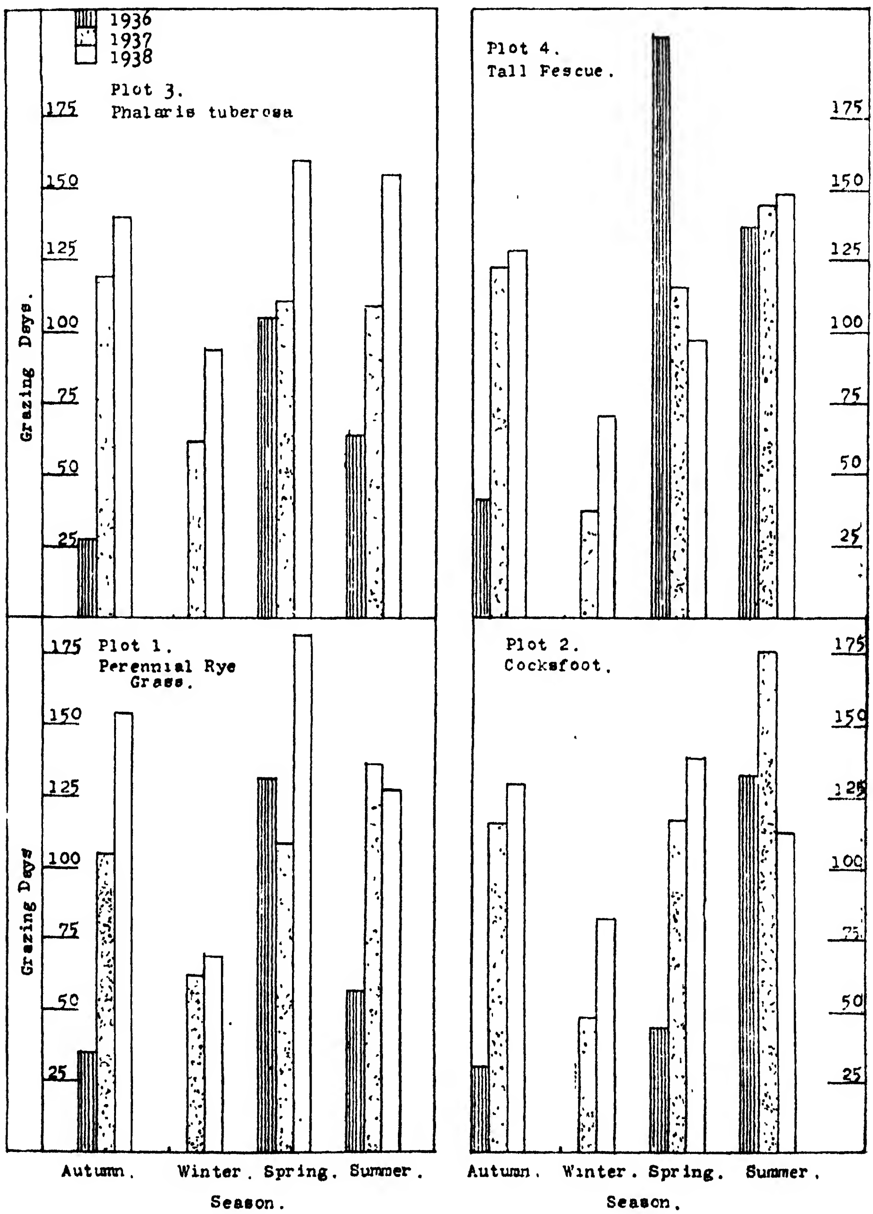
The average grazing days per month for Fields Nos. 1 to 4 for the year 1938 was 41.6, which is an increase from 35.0 grazing days per month for 1937. Field No. 5 only came into production in 1938.

It will be noted that fields Nos. 1 and 3 are still giving a steady increase in grazing days, while field No. 4 has only given a slight increase. No noticeable improvement was obtained in field No. 2 which gave the highest number of grazing days during 1937. Field No. 5 shows approximately the same production as did fields Nos. 1, 2, and 3 on their first season 1936.

The following series of graphs in Graph No. 3 show the "Quarterly Seasonal Grazing" figures for each field for the three years:—

Graph 3.

Three-Monthly Seasonal Grazing Days for the Four Fields.



An examination of these graphs will show that the autumn production of all fields has increased steadily, the best production being obtained from field No. 1—perennial rye grass, this being followed by field No. 3—Phalaris tuberosa. It is very pleasing to see the steady increase of grazing which has been obtained from all fields during the winter months, the greatest increases during 1938 being obtained from fields Nos. 2, 3, and 4.

The average spring production also has shown a decided increase. All fields, with the exception of No. 4—tall fescue, have given increased grazing. No. 4, however, has shown a decline.

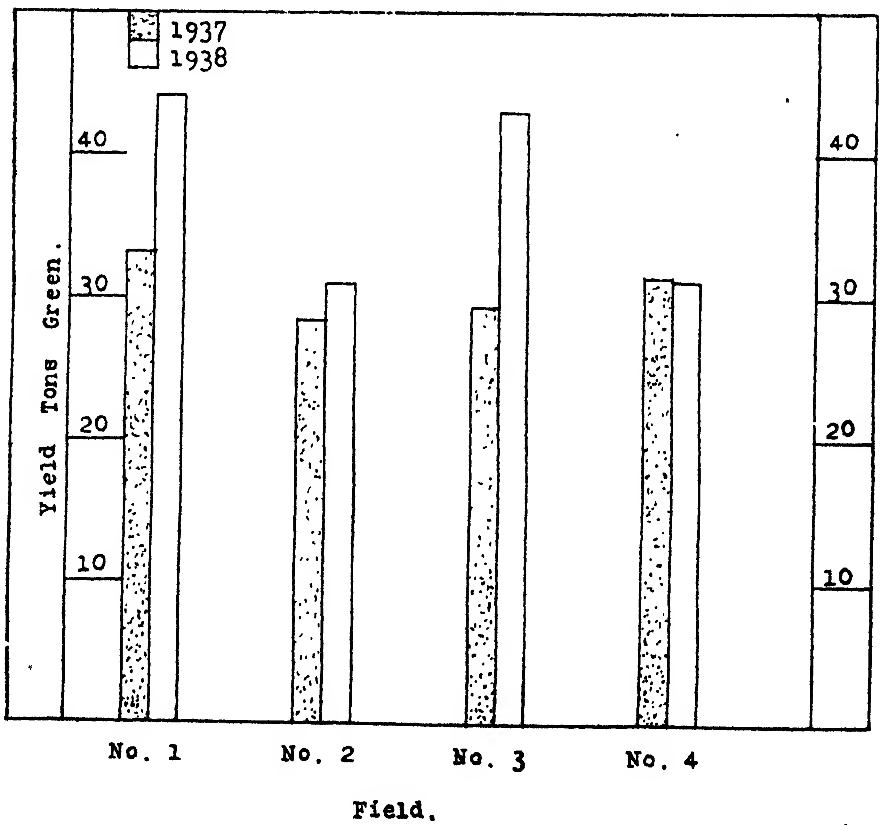
The summer production average was slightly less for 1938 than 1937, the biggest decline taking place with field No. 2—cocksfoot, with a small decline in field No. 1—perennial rye grass. Field No. 3—Phalaris tuberosa gave a decided increase over that of the previous seasons.

Yields of Green Material per Acre.

The following graph No. 4 gives the yields of green material which were obtained from each field for the two years 1937 and 1938:—

Graph 4.

Annual Production in Tons for the Four Fields.



It will be seen from the above graph No. 4 that, although a very high average yield (30.5 tons) per acre was obtained during 1937, this was exceeded in 1938, the average being 37.3 tons. Fields Nos. 1 and 3 gave very much higher yields and showed a considerable increase on that of the previous season. This increase also is reflected in graph No. 2 with the average grazing days per month obtained from these two fields.

The production in tons of green material from the four fields for the periods August to December for the three years is given in the following table No. 1.

Table No. 1.

	1936.	1937.	1938.
	Tons.	Tons.	Tons.
Field No. 1	12.7	17.7	23.9
„ No. 2	11.1	14.1	17.9
„ No. 3	10.6	15.2	22.9
„ No. 4	8 1	15.8	15.8

A decided increase is being obtained for the above period on all fields with the exception of No. 1 (tall fescue).

The following table No. 2 gives the average "Three-Monthly Yields per Acre" of all plots for the four seasons of the year:—

Table No. 2.

Season	1937.	1938.
Autumn	5.3	8.4
Winter	1.3	3.2
Spring	12.6	10.9
Summer	11.3	14.7

Comparing the figures it will be seen that a decided increase in the winter yield has taken place and that the autumn and summer production also has shown a good increase. A decrease, however, has occurred in the spring production, which is not of serious moment.

Graph No. 5 (on the following page) gives the "Three-Monthly Yields per Acre" for the four fields for two years.

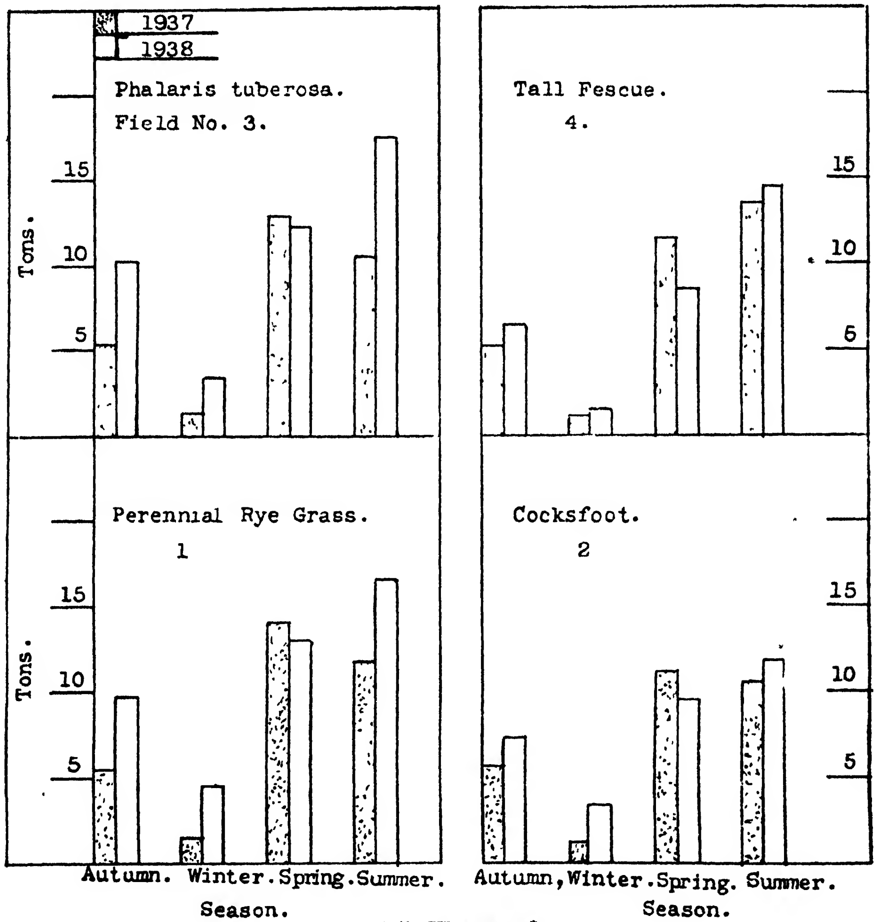
The autumn production for fields Nos. 1 to 3 has shown a decided increase over that of the previous seasons. The greatest increase in winter yield was obtained from field No. 1. Field No. 4—tall fescue only showed a slight increase in winter production. In regard to the spring production, the biggest decrease took place on field No. 4 followed by field No. 2. The other two fields only showed a slight decrease.

Fields Nos. 1 and 3 gave the greatest increases in yield for the summer production, while fields Nos. 2 and 4 only showed a slight increase over that of the previous season.

While the observations will not be completed for a further two seasons, some tentative conclusions which appear legitimate are given at the end of this article.

Graph 5.

Three-Monthly Seasonal Yields for the Four Fields.



*J. Neil, Waroona.**

The objects of the experiment are the same as those given above for Mr. C. H. Henning, Hamel.

An area of 12.94 acres was selected, divided into five fields, the area of the fields being as follows:—Fields Nos. 1, 2, 4, and 5—2.39 acres each; field No. 3—2.5 acres.

Seed Mixtures.

The seed mixtures sown were as follow. In each case certified white clover at the rate of 2 lbs. per acre was incorporated.

Field No. 1—N.Z. Certified Mother Strain Perennial Rye Grass	8 lbs. per acre
Field No. 2—New South Wales Paspalum dilatatum ..	10 lbs. „
Field No. 3—N.Z. Certified Perennial Rye Grass ..	4 lbs. „
Paspalum	8 lbs. „
Field No. 4—N.Z. Tall Fescue	8 lbs. „
Field No. 5—Certified Phalaris tuberosa	4 lbs. „

* All particulars with reference to soil, cultivation, sowing, etc., have been supplied in the March, 1937, issue of this *Journal*.

Fertiliser.

A total of 6 cwts. superphosphate per acre was applied in three applications of 2 cwts. each in February, May, and September, 1938. Four applications totalling 720 lbs. per acre were applied in 1937, and 900 lbs. superphosphate plus 100 lbs. sulphate of ammonia was given during 1936.

Irrigation.

The fields were irrigated five times during the year, viz., 12th January, 7th February, 28th February, 28th November, and 25th December, 1938.

Cultivation.

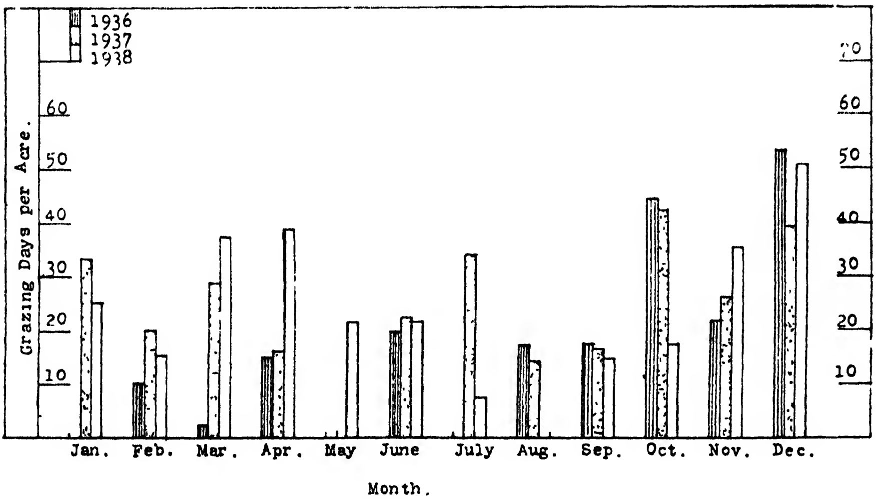
On 9th May the whole area was harrowed with a knife blade pasture type of harrows. On 25th July all fields were severely renovated with a rotary prong type of renovator double-lapped, followed by the pasture harrows. A very rapid growth response was noticed after this operation. On 30th September all the irrigation furrows were cleaned out with the altered "Sunbuster" plough.

Grazing.

Graph No. 6 gives the "grazing days" which were obtained per month from each field for the years 1936, 1937, and 1938:—

Graph 6.

Cow Grazing Days per Acre.



Carrying capacity of whole area—

1936	1 cow to 1.80 acres
1937	1 cow to 1.24 acres
1938	1 cow to 1.28 acres

Total grazing, 1938—

29,890.6 grazing hours from 12.94 acres.
2,286.6 grazing hours per acre.
285.8 grazing days per acre.

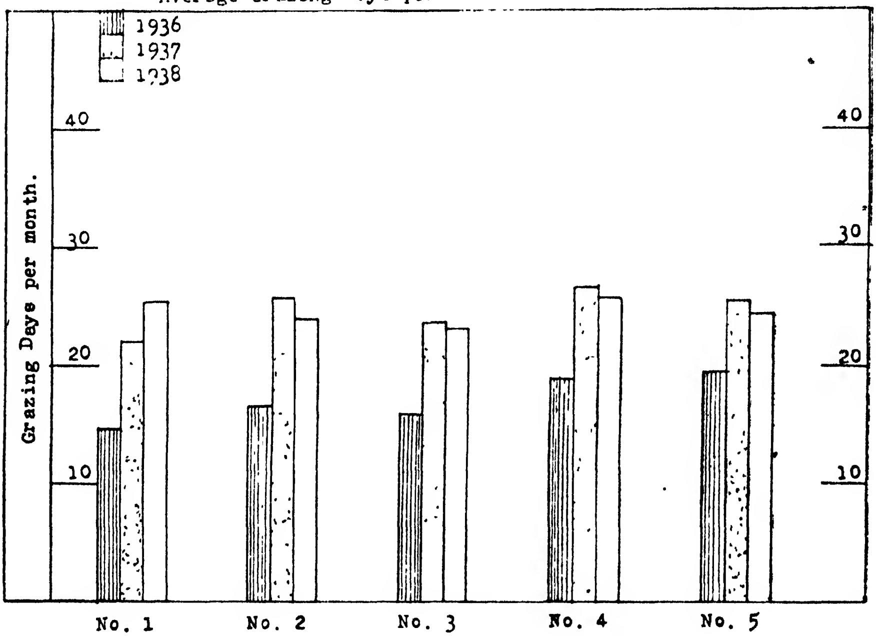
From this graph it will be seen that the actual grazing obtained for the year was slightly lower than that obtained during the previous year. This was due to lack of efficient grazing, more particularly in the late winter and spring months. Relatively good grazing was obtained for the month of May, whereas

during the previous two seasons none had been obtained for that month. No grazing was carried out in August and very little for the months of July, September, and October. The effect of under-grazing was very noticeable in October and November, when the pasture became too high and rank for efficient grazing, must wastage occurring when grazing was carried out.

The various grass species in association with white clover gave the average grazing days per month for the years 1936, 1937, and 1938 as shown on Graph 7.

Graph 7.

Average Grazing Days per month for the Three Years.



It will be observed from this graph that each species gave practically no variation in grazing days per month for the two seasons, this again being due to the grazing system adopted by the farmer during the year.

Graph 8 shows the three-monthly seasonal grazing days for the five fields for years 1936, 1937, and 1938.

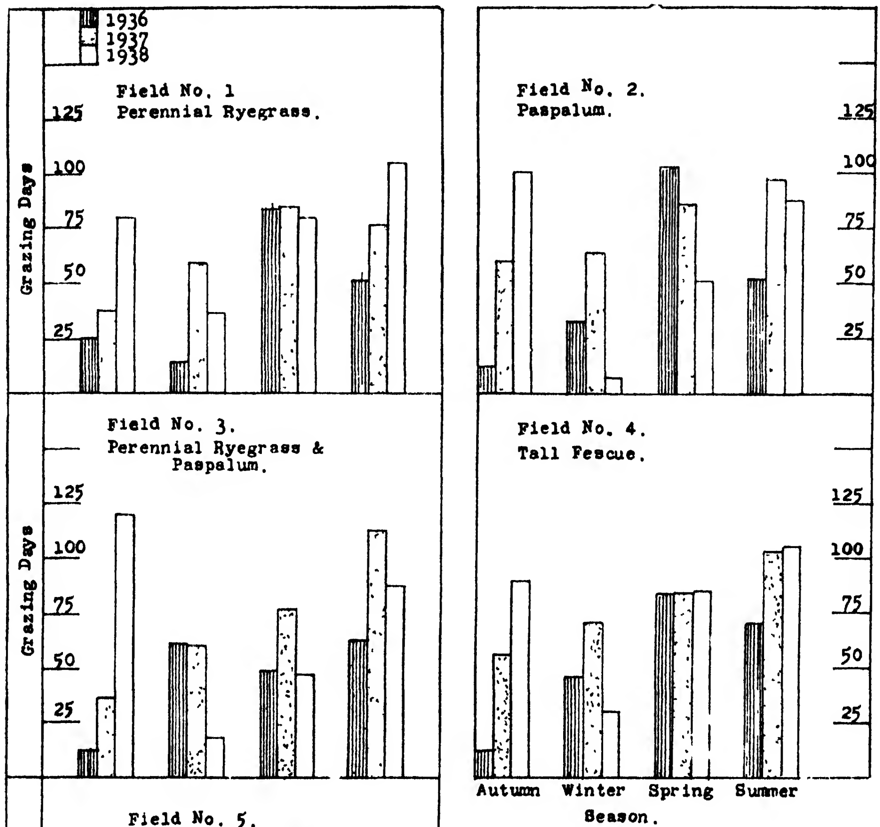
From these five series of graphs in Graph 8 it will be seen that the autumn grazing has increased considerably over the last three years on all fields, Field 3 giving the greatest increase for 1938, due to efficient grazing. The winter grazing, however, decreased considerably on all fields during 1938, although a good increase was recorded, with the exception of Field 5, for 1937, due to too light grazing during the winter of 1938.

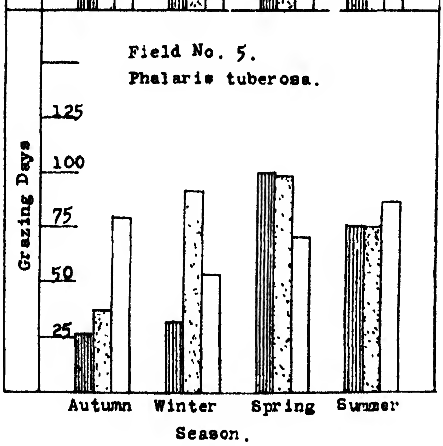
The decrease in efficient grazing commenced in May, 1938, this naturally affecting the winter, spring, and to some extent the summer grazing production, consequently no definite information can be gleaned from these figures.

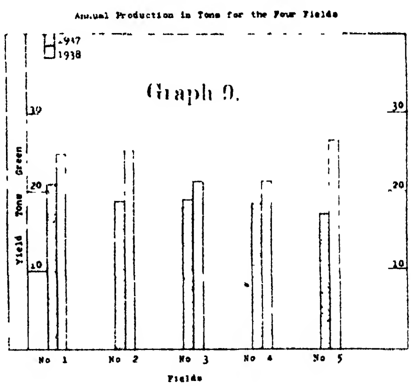
The yields of green material, however, do indicate the actual variations which occurred during the past two seasons, as is shown plainly in Graphs Nos. 9 and 10.

Graph 8.

Three-Monthly Seasonal Grazing Days for the Five Fields







Yield of Green Material.

Graph No. 9 above gives the yield of green material per acre for the five fields for the two years.

It will be seen from Graph No. 9 that good increases in yields were obtained from Fields Nos. 1, 2, and 5, while Fields Nos. 3 and 4 only gave a small increase. The highest increase was recorded from Field No. 5—Phalaris tuberosa. This

grass has shown a considerable thickening up of stand with the white clover and is now a complete sward. The average production per acre from all fields has increased from 18.9 tons in 1937 to 23.9 tons in 1938.

The following Table 3 gives the production per acre for the three-monthly seasons of the years 1937 and 1938:—

Table 3.

Season.	Tons of Green Material per Acre. 1937.	1938.
Autumn	5.4	5.4
Winter	2.0	4.5
Spring	6.4	8.2
Summer	6.8	5.8

The winter production has shown a decided increase over that of the previous season. This increase is very pleasing, as it is a season of normal low production. The spring production increased from 6.4 tons to 8.2 tons per acre, while the autumn production remained constant, and the summer yield was slightly lower than that of the previous year.

Graph No. 10 (page 49) shows the three-monthly yields for the different seasons of the year for each field. As will be seen, practically no variations occurred on the individual fields for the autumn months, but in every case there was a decided increase in the winter production, Field No. 1 showing the greatest increase, and Field No. 3 giving the least, this being due in part to the still high amount of couch grass present and the lack of complete cover by white clover.

Grateful acknowledgment is made to Mr. K. T. Lutz, Agricultural Adviser, for assisting in collecting the field information given in this article.

TENTATIVE CONCLUSIONS.

The results of the last three years show that—

1. The growth of white clover during the first year of establishment may be checked seriously by the more rapid growth of perennial plants, particularly perennial rye grass. This condition can be avoided to a great extent by not seeding in excess of 4 lbs. of perennial rye grass per acre, and by efficiently controlling the grazing during the initial season. A good mixed sward, however, is usually obtained the following year.

2. Observations indicate that, where under-grazing has taken place, grass species have tended to "take charge" to the detriment of white clover. This occurs more seriously where paspalum and couch grass are the associated species. Where excessive over-grazing occurs during the summer and winter months, the reverse takes place. White clover will tend to predominate to the exclusion of such associated species as perennial rye grass, Phalaris tuberosa, and cocksfoot.

3. Phalaris tuberosa and white clover associate well under irrigated condition, provided rotational grazing is efficiently managed.

4. Paspalum and white clover can be established rapidly under irrigated conditions. Careful late spring and summer grazing is necessary, otherwise the paspalum will become "tussocky."

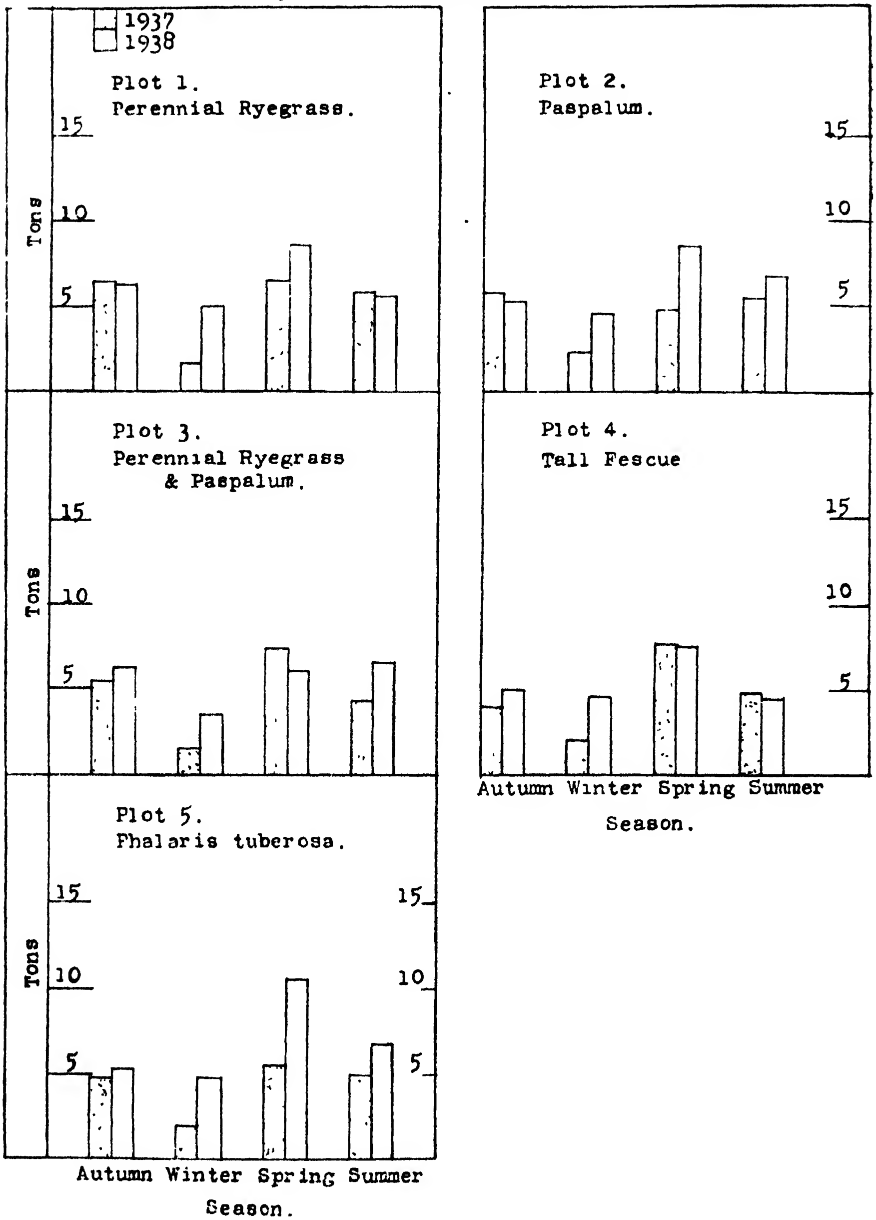
5. A mixture of cocksfoot and white clover is proving successful under existing conditions, but cannot be recommended yet for general adoption.

6. Further work on the management of tall fescue is necessary before this grass can be recommended for inclusion in a mixture for irrigated land, owing to its tendency to become "tussocky."

7. Perennial rye grass and cocksfoot association with paspalum and white clover appears to assist in preventing matting of the pasture, thereby assisting in maintaining a prolific sward.

Graph 10.

Three-Monthly Seasonal Yields for the Five Fields.



8. Winter and spring harrowing is essential to break up and distribute animal droppings. Topping with a mower during the late spring is beneficial.

9. Surface renovation is essential on paspalum pastures to maintain an adequate proportion of clover growth.

10. At least 5 cwt. of superphosphate per acre should be applied in three applications per annum on irrigated land, the heaviest application being given in the autumn.

GRADING AND MARKETING OF TOBACCO LEAF.

A. SHARP,
Tobacco Adviser.

No matter how careful the tobacco grower may have been in the cultivation, harvesting and curing of his crop, he will find that his bulks contain leaf of a number of different types. In the first place, the leaf can be divided broadly into three classes, viz. bottom, middle and top, according to the position in which it grew on the plant. Under Western Australian conditions, bottom leaf is usually fairly thin, sometimes inclined to be papery and lacking in body, and is almost invariably damaged to a greater or less extent by blue mould, grasshopper injury, etc. The leaf from the middle portion of the plant is the best, while the top leaf is smaller, rather narrow in proportion to its length, and has a tendency to be coarse.

Within each of these classes will be found considerable variation in colour, from the much-prized "Lemon" and "Bright Mahogany," down through "Mahogany" to "Dark" and "Green." As the different types of leaf are required by the manufacturers for different purposes, it is necessary for the grower to sort them carefully into grades if he is to receive the highest financial returns for his crop. The principal manufacturing firms in Australia now insist that all leaf be properly graded and handed before being offered for sale, and there is little doubt that the unsatisfactory prices obtained by some growers in the past have been due to careless grading and lack of attention to detail in the "get up" of the leaf generally.

THE GRADING SHED.

The first requirement for good grading is a properly constructed grading shed of ample size. Such a shed need not be of elaborate construction, but there are one or two points which should be borne in mind when designing it. It is usual to combine the bulk and grading shed under one roof. As grading is carried out mainly during the months of May, June and July, when heavy and continuous rain may be expected, it is advisable to have the shed built well off the ground and to have it lined either with asbestos-cement sheets or some other damp-proof material, otherwise the leaf is liable to absorb an excessive amount of moisture during handling with consequent risk of developing mould. The south wall of the shed should be fitted with ample window space so that plenty of diffused light can fall on the grading bench. It is extremely important that the direct rays of the sun should not be allowed to fall on the leaf, as its true colour cannot be judged in direct sunlight. The only equipment required is a grading bench or benches fitted with compartments for holding the various grades of leaf.

GRADING.

The quality of tobacco leaf is determined, for buying purposes, by its colour, texture, size and soundness, and of these, colour is the most important. At present, grading is carried out almost entirely on a colour basis. This does not necessarily mean that the light-coloured leaf which fetches the highest price ultimately produces the best "smoke," but the present fashion demands this type and it is therefore the grower's business to meet that demand as far as possible.

The number of grades into which the leaf is sorted will depend on the uniformity or otherwise of the crop. Generally speaking, it will be found that seven colour grades will be sufficient to meet the buyers' requirements. These grades might be described as follows:—

(1) First Grade Bright Mahogany (BM1).—Clear bright yellow or slightly orange colour, sound and free from blemish and of good texture, *i.e.*, having plenty of toughness and elasticity. Must not show any green tinge.

(2) Second Grade Bright Mahogany (BM2).—Very slightly darker than BM1 and of good texture. Small amount of sponging and other blemishes permissible, but must not show any tinge of green.
(3) Third Grade Bright Mahogany (BM3).—Slightly darker than BM2, good texture, and may carry a proportion of less sound, sponged and blemished leaf. No leaf showing green should be included.
(4) Inferior Bright (IB).—Will include all leaf of bright mahogany colour which is too badly blemished and broken to be included in the first three grades.
(5) Mahogany (M).—Reddish brown colour, may be somewhat sponged and blemished, but thoroughly mature and showing no green.
(6) Dark Mahogany (D).—Very dark brown, coarse-textured leaf, usually from the top of the plant.
(7) Green (G).—All leaf showing the least tinge of green.

It will be noted that no mention is made here of a "Lemon" grade. The amount of leaf produced in most Western Australian crops which can be classed as lemon is so small that it is hardly worth while making a separate grade of it, whereas if it is included as BM1 it will tend to improve the general appearance of that grade.

It is very doubtful whether the sixth grade mentioned here (Dark Mahogany) will be saleable in future. Under the conditions obtaining at Manjimup, leaf which fails to cure a bright colour has usually been spoilt through exposure to adverse weather conditions or has been picked in an immature condition. Such leaf can be used by manufacturers only in very small quantities.

The seventh grade (Green) may be divided into two parts:—
(1) Bright leaf showing only a faint tinge of green.
(2) Leaf showing a definite amount of green.

These should be bulked separately until the whole of the crop has been graded, when the first grade greens can be gone through again, when it will probably be found that much of the green tinge has disappeared, and the leaf can be regraded into the various bright mahogany grades.

Another grade which may have to be included in the case of some crops is for leaf of good colour but of harsh, woody texture. Such leaf may have quite good smoking characteristics as raw leaf, but it has been found that it refuses to respond to the various manufacturing processes, and buyers insist that its presence in the bright mahogany grades is highly detrimental. Leaf of this description should therefore be rigidly excluded from the higher grades.

In addition to grading for colour, the leaf should be sorted according to size. In the case of moderate crops having no very large leaf, two sizes will be sufficient—medium and small—but where the crop includes leaf over, say, twenty inches in length it is advisable to include three sizes. All leaf under 12 inches in length should be classed as "small" and handed and baled separately. Leaf over 12 inches in length should be divided into "medium" and "large" and tied up separately but may be baled together.

Grading should not commence until the leaf has been at least five or six weeks in the bulk. Under the weather conditions experienced in this State it is impossible to start grading in any case until the autumn rains have started in April, unless steps are taken to artificially humidify the atmosphere of the grading shed, so that most of the leaf is actually over two months in bulk before being graded.

It frequently happens that the leaf in the bulk is found to be rather too dry to permit of being handled without breaking. If it has been bulked "on the stick" it is a simple matter to hang up a sufficient quantity overnight for the following day's grading, when it will usually be found that sufficient moisture has been absorbed to soften it. Should the leaf have been bulked off the stick, the best plan is to turn the bulk during wet weather a short time before grading is due to commence.

HANDING.

When the leaf has been sorted into the various grades it is tied into hands, each containing from a dozen to twenty leaves according to size. The butts of the finished hands should not be more than one inch in diameter. When made larger than this they look untidy and are liable to fall apart on handling. To tie a hand, a leaf of the same grade is folded along the midrib, with the upper surface to the outside, and wrapped tightly round the butts of the leaves several times, the butt end then being tucked into the middle of the hand. When finished, the tie leaf should extend from just beyond the extreme end of the butts to about 1½ to 2 inches down the hand. Neatly tied hands of the proper size help very greatly to show the leaf off to advantage.

After being tied into hands the leaf is again bulked until sufficient has accumulated to fill a bale, care being taken not to get the grades mixed. These loose bulks should be kept carefully covered to prevent the absorption of too much moisture by the leaf.

BALING.

The standard size bale in use in this State measures 36in. x 22in. x 18in. and contains about 180 lbs. of leaf. It should be wrapped in new 14oz. hessian. A lining of brown paper is sometimes used inside the hessian but is not necessary. In baling, a length of hessian 3 feet wide and long enough to go right round the bale with a few inches overlap is placed on the floor of the press, the sides of which are then fixed in position. The hands are placed with the butts towards the two ends of the bale, a layer being placed at each end alternately and a binding layer being built into the centre as required. All leaf must lie along the length of the bale; on no account should the binding layers be placed crosswise.

Having filled the press, the lid is laid in position and pressure applied by means of a screw or jack. This first pressure reduces the volume of the leaf by about half. The pressure is released after a few minutes, the lid removed, and the press again filled with leaf, after which pressure is again applied. The completed bale should be left under pressure for at least one hour, otherwise the natural spring of the leaf will cause it to lose compactness. If the tobacco is to be stored on the farm pending the visit of the buyers—as is usually the case in this State—the bale should not be stitched, but should be simply held together by means of three ropes passed round it and tied firmly. This allows of easy examination by the buyer and the replacement of the sample hands drawn for inspection. After purchase, the bales can be stitched, the ropes removed, and the caps sewn on the ends. The ropes should not be left on the bales as their presence during transport tends to injure a portion of the leaf.

As far as possible, only one grade of leaf should be placed in any one bale. If small parcels of various grades are left over, however, it is permissible to make up a bale of two, or even three, grades, placing a layer of paper between them. Bright and dark leaf, however, should not be included in the same bale.

Before despatch to the factory, each bale should be clearly stencilled with the grower's brand, the buyer's grade mark, and the buying company's brand. All marks should appear on one side of the bale only.

MARKETING OF LEAF.

The system of marketing the leaf grown in this State by the small private growers has hitherto been that known as "farm buying." Under this system the buyer visits each grower, usually in July or August, and closely inspects a number of hands drawn from each bale. A price is offered for each grade of useable leaf and, if acceptable to the grower, the sale is finalised on the spot and the grower agrees to despatch the leaf to the factory by a given date. Until the present, there

has been only one bidder from the Eastern States for the Western Australian crop, but evidence has recently been obtained that at least one other Eastern States manufacturing concern would be prepared to purchase quantities of Western Australian leaf provided that it was put up for auction.

There would appear to be little doubt that the advent of a certain amount of competition among buyers for this State's crop would place the industry on a more secure footing than has hitherto been the case, and would engender a feeling of confidence among the growers.

The system of farm buying suffers from a number of rather serious disadvantages, apart from the absence of competition for the leaf. Very few growers in Western Australia have sufficient well lighted shed accommodation to set out their crop to proper advantage. More often than not the sample hands on which prices are appraised have to be taken into the open air for examination, and during wet weather the conditions under which the buyers operate can be rather uncomfortable. The system also involves a great deal of travelling on the part of the buyers, frequently over rather indifferent roads and bush tracks, and it is only reasonable to suppose that the quite considerable expense involved is reflected in a somewhat lower price being offered for the leaf than might otherwise be the case. Another serious disability lies in the fact that the average grower has little opportunity of comparing the quality and "get up" of his crop with that of others, and when he fails to receive what he considers a satisfactory price for his leaf he is inclined to blame the judgment of the buyer rather than to realise that his methods of handling his leaf have been faulty.

The system of sale by auction, which has been in vogue in Queensland for a number of years, would appear to be a definite advance on farm buying. Under this system, the crop, after grading, handing and baling, would be despatched to one or other of the big wool-selling floors at Fremantle, where it would be set out for inspection under ideal conditions. The buyers would have ample opportunity to appraise each lot carefully, and the whole Western Australian crop could probably be disposed of expeditiously at a single auction. Growers would also have the opportunity of meeting each other on the floor and of inspecting the grading and "get up" of crops other than their own. This would undoubtedly tend towards improvement and standardisation of the crop as a whole.

PIG FEEDING EXPERIMENT—MURESK AGRICULTURAL COLLEGE.

SUPPLEMENTS SUITABLE FOR FEEDING WITH WHEAT.

H. J. HUGHES, B.A., Late Principal; C. R. DIXON, Pig Husbandryman.

The following feeding experiments, which were originally designed as a demonstration to farmers attending the Short Winter Course last August at The Muresk College, have given such valuable and interesting results, that it has been thought desirable to make the information available to all farmers through this Journal.

Six groups of pigs were selected, each group containing four or five pigs, as nearly matched for weight and quality as possible. Each individual pig was marked for identification, and weighed at seven-day intervals throughout the feeding period, which was 16 weeks.

The pigs selected were weaners and all first crosses of the Tamworth and Berkshire breeds.

The rations fed to the various groups were as follow:—

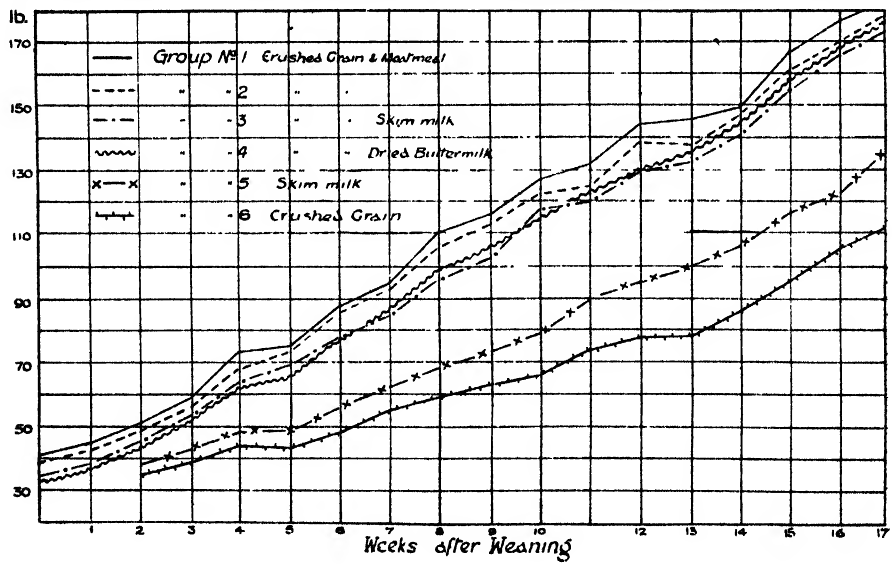
Group 1.—Crushed wheat with meat meal.
Group 2.—Crushed wheat with meat meal.
Group 3.—Crushed wheat with skimmed milk.
Group 4.—Crushed wheat with dried butter milk.
Group 5.—Skimmed milk only.
Group 6.—Crushed wheat only.

All pigs received a quantity of green fodder daily, and were allowed access to a suitable run for exercise.

The proportions of the various supplements fed with the crushed wheat are shown in table 1. It will be noticed that the quantity of these supplements remained practically constant, indicating that the young pig requires a ration relatively high in protein in comparison with its requirements as bacon weights are reached.

Until the eleventh week after weaning the rations were increased at fortnightly intervals, after which it was found desirable to increase the daily ration each week. As in most cases where stock are being fed, it was found that individual animals were outstanding in their capacity to convert the food they consumed into meat, and indicates the great advantages which might accrue from a consistent policy of selection from those families which produce such individuals for breeding stock. The average results however of each group are a more true record of what might be expected in practice, and are shown for convenience in graph form below, which brings out the salient differences between the groups more clearly than figures.

A COMPARISON OF SUPPLEMENTS FOR FEEDING WITH WHEAT TO PIGS.



A study of this graph shows a number of interesting points:—

1. It will be noticed that the four groups receiving crushed wheat and a suitable concentrate were for practical purposes equal in their rate of growth. The two groups receiving meat meal for their concentrate were slightly heavier at the start

Table I.

RATIONS FED TO PIGS IN EACH GROUP.

Date.	Group 1.		Group 2.		Group 3.		Group 4.		Group 5.	Group 6.
	Per Pig per day.		Per Pig per day.		Per Pig per day.		Per Pig per day.		Per Pig per day. Skim Milk (only).	Per Pig per day. Grain (only).
	Grain.	Meatmeal.	Grain.	Meatmeal.	Grain.	Skim Milk.	Grain.	Butter-milk (Dried).		
	lbs.	lbs.	lbs.	lbs.	lbs.	gall.	lbs.	lbs.	gall.	lbs.
27th May–3rd June	½	¼	½	¼	½	½	½	¼	...	...
3rd–10th June	1	½	1	½	1	¾	1	½	...	...
10th–17th June	1½	½	1½	½	1½	¾	1½	½	¾	¾
17th–24th June	2	½	2	½	2	¾	2	½	1	1
24th–1st July	2	½	2	½	2	¾	2	½	1¼	1¼
1st–8th July	2½	½	2½	½	2½	¾	2½	½	1½	1½
8th–15th July	2½	½	2½	½	2½	¾	2½	½	1½	1¾
15th–22nd July	3,	½	3	½	3	¾	3	½	1¾	2
22nd–29th July	3	½	3	½	3	¾	3	½	2	2½
29th July–5th August	3½	½	3½	½	3½	¾	3½	½	2	2½
5th–12th August	3½	½	3½	½	3½	¾	3½	½	2½	3
12th–19th August	4	½	4	½	4	¾	4	½	2½	3½
19th–26th August	4½	½	4½	½	4½	¾	4½	½	3	3½
26th August–2nd September ...	5	½	5	½	5	¾	5	½	3	4
2nd–9th September	5½	½	5½	½	5½	¾	5½	½	3½	4¼
9th–16th September	6	½	6	½	6	¾	6	½	4	4½
16th–23rd September	6½	½	6½	½	6½	¾	6½	½	4½	5

than the groups receiving skim milk or dried butter milk, and these groups finished the feeding experiment with approximately the same difference between the average weights.

2. Half a pound of dried butter milk was equivalent to approximately three-quarters of a gallon of skimmed milk, and in turn equivalent to half a pound of meat meal.

3. Skimmed milk, with green material, is not an efficient ration for growing pigs. Although this group was fed for two weeks less than the groups 1-4, even if the rate of growth had been maintained for another two weeks these pigs would have been about twenty pounds lighter than in the other four groups. Apart from this, however, it was noticeable that although these skim milk fed pigs appeared sleek they were "big bellied" and soft in appearance, and experience has shown that they would kill out too fat and "soft."

4. The wheat only fed pigs were obviously unhealthy all through the fourteen weeks that they were being fed. Their coats were rough and the pigs had the appearance aptly described as "pot-bellied." One of these pigs was killed for demonstration purposes about three months after the feeding began and besides being very stunted in growth showed a carcase which was far too high in fat for trade requirements. This group showed an average weight which was approximately 60 lbs. less than the pigs in group 1 at the same age, which received meat meal as a supplement. It can safely be said that although skim milk alone may eventually produce a pig which is saleable as a bacon pig, although not of prime quality, pigs fed on wheat alone never will produce a bacon pig which is saleable at a reasonable price.

5. It will be noticed that the curves showing the average growth per week for each group, do not rise at a constant rate. This is more particularly the case with groups 1 and 2, and to a lesser extent with group 3, receiving skim milk.

This is an indication of the care and attention to the individual requirements of pigs necessary by attendants if the best results are to be obtained. From the 27th May to 12th August, or for eleven weeks, the ration was increased each fortnight and for the first month this practice gave good results. After this period however, and as a result of weighing the pigs weekly and comparing the weights, it was noticed that some groups seemed to grow more rapidly for a week and then slow down for a week, as is shown by the steps in the graph. These slow periods of growth were found to coincide with the second week of the ration period, more rapid growth taking place during the following week when the ration was increased. From the twelfth week, however, the rations were increased each week, and it will be noticed that the graph continued in an almost smooth upward curve for all groups after this time.

Although the only way of ascertaining that pigs are being economically fed is to weigh regularly, this may not always be possible in practice, but feeders should be careful to see that pigs are receiving an adequate ration, which can be ensured by feeding regularly at least twice per day and as much as they can clean up in about 15 minutes. The self feeding of pigs of course does away with this supervision to a great extent.

Cost of Supplements.

In all feeding trials two aspects must be considered, firstly, the suitability of the ration for the purpose for which it is being used, and secondly the cost of that ration. The present experiments give some interesting information on the cost of feeding pigs under wheatbelt conditions, in comparison with those in dairy districts.

Tables 2 to 8 below have been prepared to show this information.

Table 2.

	Group I.	Group II.	Group III.	Group IV.	Group V.	Group VI.
Average weight at weaning (lbs.) ...	40	39	35	32	39	36
Average weight at end of experiment (lbs.)	181	178	173	177	135	111
Average gain per pig (lbs.) ..	141	139	138	145	96	75
Weight of crushed wheat consumed per pig (lbs.)	396	396	396	396	...	295
Weight of meatmeal consumed per pig (lbs.)	58	58	...	..	.	...
Weight of butter-milk (dried) consumed per pig (lbs.)	...	.	..	58	...	...
Gallons of skim-milk consumed per pig	..	...	88	...	243	.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d	£ s. d.
Total cost of feed per pig .	1 11 2	1 11 2	1 12 3	1 17 6	1 0 3	0 18 5
Weight of feed per lb. live weight gain (lbs.)	3·24	3·26	3·52	3·13	2·53	3·93
Average cost per lb. live weight gain (pence)	2·67	2·69	2·80	3·10	2·53	2·94

REMARKS:—

GROUP I.—Fed crushed wheat and meat meal—healthy and vigorous.

GROUP II.—Fed crushed wheat and meat meal. Very even group. Three pigs out of this group were judged first in the Royal Show Export Baconer Class.

GROUP III. Fed crushed wheat and skim milk. Selected from same litter as Group II. Bigger variation in individual weights than in Group II.

GROUP IV.—Fed crushed wheat and dried butter-milk. Most robust of the six pens. Skin and hair of better appearance than above Groups.

Group V.—Fed skim milk only. Unthrifty appearance, long-haired and slightly pot-bellied.

GROUP VI. Fed crushed wheat only. Sickly, stunted appearance. Worst appearance of all the groups. Long-haired and pot-bellied.

Table 3.

GROUP I.

CRUSHED WHEAT AND MEAT MEAL.

Weight Week ending	No. 1. lbs.	No. 2. lbs.	No. 3 lbs.	No. 4. lbs.	Average. lbs.	Average Gain. lbs.
27th May .. .	41	42	35	45	40·33	
3rd June	45	46	38	49	44	3·66
10th June ..	50	54	46	56	50·66	6·66
17th June	59	60	53	66	59·33	8·66
24th June	74	72	66	79	73	13·66
1st July	77	77	70	81	76	3
8th July . ..	89	91	83	93	88·33	12·33
15th July	95	97	90	101	95·33	7
22nd July	111	111	105	114	110	14·66
29th July	118	117	112	119	116·33	6·33
5th August ..	127	131	125	130	127·66	11
12th August ...	131	137	128	135	131·33	4
19th August ...	145	Killed for	141	146	144	12·66
26th August ...	146	demonstra-	144	147	145·66	1·66
2nd September ...	147	tion	149	152	149·33	3·66
9th September ...	164		164	171	166·33	17
16th September ...	175		179	182	178·66	12·33
23rd September ...	177		179	187	181	2·33

Table 4.

GROUP II.

CRUSHED WHEAT AND MEAT MEAL.

Weight Week ending	No. 1 lbs.	No. 2. lbs.	No. 3. lbs.	No. 4. lbs.	No. 5. lbs.	Average lbs.	Average Gain lbs.
27th May	46	39	38	38	34	39	...
3rd June	49	42	40	42	36	41·8	2·8
10th June	54	48	46	48	44	48	6·2
17th June	62	57	55	56	52	56·4	8·4
24th June	76	68	66	68	63	68·2	11·8
1st July	80	72	71	74	68	73	4·8
8th July	93	87	83	88	82	86·6	13·6
15th July	96	94	88	95	88	92·2	5·6
22nd July	110	107	104	109	99	105·8	13·6
29th July	116	112	112	114	104	111·6	5·8
5th August . ..	127	123	122	125	114	122·2	10·6
12th August	131	124	125	127	115	124·4	2·2
19th August	146	140	139	140	129	138·8	14·4
26th August	146	140	141	139	126	138·4	-0·4
2nd September	154	149	149	148	137	147·4	9·0
9th September	168	161	163	163	149	160·8	13·4
16th September ...	177	168	173	173	157	169·6	8·8
23rd September ...	183	177	180	181	167	177·6	8·0

Table 5.

GROUP III.

CRUSHED WHEAT AND SKIM MILK.

Weight Week ending	No. 1. lbs.	No. 2. lbs.	No. 3. lbs.	No. 4. lbs.	No. 5. lbs.	Average lbs.	Average Gain lbs.
27th May	44	31	36	34	28	34·6	...
3rd June	48	35	38	39	32	38·4	3·8
10th June	57	42	47	46	40	46·4	8·0
17th June . ..	62	48	54	54	46	52·8	6·4
24th June	76	58	63	66	53	63·2	10·4
1st July	86	60	71	72	57	69·2	6·0
8th July	92	68	82	82	66	78	8·8
15th July	98	74	91	86	76	84·2	6·2
22nd July	108	86	104	98	84	96	11·8
29th July	114	94	111	104	88	102·2	6·2
5th August	129	108	128	119	100	116·8	14·6
12th August	132	114	130	120	104	120	3·2
19th August	139	120	141	130	114	128·8	8·8
26th August	145	128	146	136	108	132·6	3·8
2nd September	150	135	150	143	124	140·4	7·8
9th September	164	159	165	155	134	155·4	15·0
16th September ...	178	165	175	169	145	166·4	11·0
23rd September ...	186	172	180	175	154	173·4	7·0

Table 6.

GROUP IV.

CRUSHED WHEAT AND DRIED BUTTER-MILK.

Weight Week ending	No. 1. lbs.	No. 2. lbs.	No. 3. lbs.	No. 4. lbs.	Average lbs.	Average Gain lbs.
27th May	33	32	33	31	32·25	...
3rd June	37	37	38	36	37	4·75
10th June	45	44	46	42	44·25	7·25
17th June	52	52	54	50	52	7·75
24th June	62	62	67	57	62	10·0

Table 6—*continued.*

Group IV.—*continued.*

Crushed Wheat and Dried Butter-Milk—*continued.*

Weight Week ending	No. 1. lbs.	No. 2. lbs.	No. 3. lbs.	No. 4. lbs.	Average lbs.	Average Gain lbs.
1st July	69	64	72	62	66·75	4·75
8th July	80	76	83	72	77·75	11·0
15th July	91	85	90	79	86·25	8·5
22nd July	105	98	102	90	98·75	12·5
29th July	111	104	109	97	105·25	6·5
5th August ...	124	114	122	108	114·25	9·0
12th August ...	130	123	126	111	122·5	8·25
19th August ...	138	130	135	115	129·5	7·0
26th August ...	142	133	143	121	134·75	5·25
2nd September ...	153	144	153	132	145·5	10·75
9th September ...	166	157	166	143	158	12·5
16th September ...	179	167	179	150	168·75	10·75
23rd September ...	188	172	191	157	177	8·25

Table 7.

GROUP V.

SKIM MILK ONLY.

Weight Week ending.	No. 1. lbs.	No. 2. lbs.	No. 3. lbs.	No. 4. lbs.	Average lbs.	Average Gain lbs.
10th June	40	38	38	39	38·75	...
17th June	43	43	43	41	42·5	3·75
24th June	50	48	48	46	48	5·5
1st July	50	49	49	48	49	1·0
8th July	56	57	56	56	56·25	7·25
15th July	65	63	61	61	62·5	6·25
22nd July	69	69	67	66	67·75	5·25
29th July	72	75	72	72	72·75	5·0
5th August ...	80	82	81	73	79	6·25
12th August ...	92	92	90	85	89·75	10·75
19th August ...	96	98	95	93	95·5	5·75
26th August ...	99	103	101	97	100	4·5
2nd September ...	105	110	108	104	106·25	6·75
9th September ...	114	116	120	116	116·5	9·75
16th September ...	121	120	125	122	122	5·5
23rd September ...	132	134	137	137	135	13·0

Table 8.

GROUP VI.

CRUSHED WHEAT ONLY.

Weight Week ending	No. 1. lbs.	No. 2. lbs.	No. 3. lbs.	No. 4. lbs.	Average lbs.	Average Gain lbs.
10th June	33	39	35	40	35·66	...
17th June	35	42	38	43	38·33	2·66
24th June	41	48	45	50	44·66	6·33
1st July	39	48	45	50	44	—0·66
8th July	41	58	47	56	48·66	4·66
15th July	47	65	54	62	55·33	6·66
22nd July	50	70	58	67	59·33	4·0
29th July	53	76	61	70	63·33	4·0
5th August ...	55	81	63	80	66·33	3·0
12th August ...	59	92	69	87	73·33	7·0
19th August ...	62	98	71	Killed for demonstration	77·0	3·66
26th August ...	64·	97	71		77·33	0·33
2nd September ...	70	109	80		86·33	9·0
9th September ...	77	124	86		95·66	9·33
16th September ...	83	138	94		105·0	9·33
23rd September ...	90	143	99		110·66	5·66

Tables 3 to 8 show that in groups 1-4, the daily gains of the pigs were approximately constant, the slight favour in the case of the dried milk group not being significant. This average gain of approximately 1.2 lbs. per days is rather greater than is obtained in most commercial piggeries and is quite satisfactory.

In the case of groups 5 and 6, however, receiving respectively skim milk only and wheat only, the daily gains are distinctly lower, being most unsatisfactory in the case of wheat only pigs. This is an excellent demonstration of the losses which are being experienced in the two types of districts represented by these uneconomical rations, namely, the dairy belt and the wheat belt. Attendance at almost any large pig sale will reveal that many pigs are still being fed on these poorly balanced rations, with loss not only to the grower, but also to the purchaser, who endeavours however to safeguard himself against loss by giving a reduced price for such animals.

Table 2 sets out clearly the costs of the various rations used and indicates that with wheat at 3s. 9d., which was the average price during the experiment, and skim milk at 1d. gallon there is practically no difference in the cost of raising bacon pigs in the wheat belt or in the dairy districts, namely, 31s. 2d. and 32s. 3d. respectively.

Dried buttermilk, however, which was donated by the South-West Co-operative Dairy Farmers Ltd., although efficient as a substitute for skim milk, proved more costly at a market price of £24 16s per long ton. The pigs in this group cost 37s. 6d. for their ration, without green stuff, but would have returned a handsome profit to the feeder at prices ruling during the experiment.

It will be noticed that the quantity of skim milk fed with the crushed wheat was approximately 2¼ lbs. for each 1 lb. of grain, which is considerably less than is usually fed on farms where skim milk is available, but the intention was to feed the skim milk so that the utmost use could be made of the supply available, and it is believed that the most profit would be made from skim milk by feeding it in such a proportion. This would, of course, mean that more pigs would have to be fattened per cow than is the custom to-day, but should mean, especially while present prices continue, that profits from this source of revenue on dairy farms would be greater.

It will also be noticed that approximately 6½ bushels of wheat is required to grow a pig from a weaner weight of 36-40 lbs. to a live weight of approximately 180 lbs. corresponding to a carcase weight of about 130 lbs. for pigs finished with such rations.

It is of interest to record that three pigs from group No. 2 were entered for the Perpetual Executors trophy for pen of 3 Export Bacon Pigs at the Royal Show last year, and were successful in gaining first place, scoring particularly well in the points awarded for suitability of carcase after slaughter.

The writers desire to express their thanks to the Superintendent of Dairying, Mr. G. K. Baron-Hay, for suggesting the above experiments, and for assistance in tabulating and preparing the above information for publication.

THE INFLUENCE OF METHODS OF PLANTING ON THE EFFECTIVE INOCULATION AND ESTABLISHMENT OF SUBTERRANEAN CLOVER.

INOCULATION EXPERIMENTS, 1938.

W. P. CASS SMITH, Plant Pathologist.
H. A. J. PITTMAN.*

Introduction.

EXPERIMENT I.

Of recent years in Western Australia the necessity for establishing suitable leguminous pastures for the development of our livestock industries, and for the improvement of soil fertility, has been emphasised in many quarters. Figures supplied by the Government Statistician show that this need is widely appreciated, for in 1932 the area under sown pasture was only 430,547 acres, whereas in 1937 the area had been increased to 741,688 acres, the sowing during this latter year alone exceeding 100,000 acres.

As these pastures, which consist very largely of subterranean clover, are initially established on virgin soils where the requisite rhizobial bacteria for effective inoculation are likely to be lacking, the introduction of the bacteria to the soil with the seed at planting time is generally essential if healthy vigorous stands are speedily to be obtained.

Fairly effective plant inoculation appears to have been secured in certain instances by sowing badly cleaned samples of seed, containing soil particles carrying the bacteria, but the risk of spreading weeds, diseases and insect pests, such as red mite (*Halotydeus destructor*) and lucerne flea (*Sminthuris viridis*) incurred in this method of introducing the root nodule bacteria to the soil, is a serious disadvantage from which the method of pure-culture seed-inoculation does not suffer.

The necessity for inoculating seeds of the true clovers (*Trifolium* sp.) and other legumes such as peas, lupins lucerne, beans, etc., with effective strains of root nodule bacteria prior to planting new areas, is now well recognised in W.A., for during the year ending June 30, 1938, some 1,700 bacterial cultures were supplied by the Department of Agriculture, at small charges, to farmers for this purpose.

The number of each kind of culture, the quantities of seed this would inoculate (at rates of inoculation recommended to farmers), together with the sown acreages this represents, is shown in Table 1.

TABLE 1.

Pure Culture Strain of Rhizobium	No. and kind of culture supplied, 1937 38	Lbs. of Seed this total would Inoculate.	Acreage this total would Sow at Average Sowing Rates.
		lbs.	acres.
Clover	958	80,640	40,320
Pea	337	40,290	896
Lucerne	195	9,105	1,138
Lupin	98	15,970	1,058
Tangier Pea	45	2,820	940
Cow Pea	27	1,380	92
French Bean	19	840	8
Lotus	13	210	105
Soya Bean	6	210	7
Lespedeza	2	30	10
	1,700	151,395	44,574

* Formerly Plant Pathologist. Resigned on August 23, 1938, to become Principal, Dookie Agricultural College, Victoria.

Numerous reports from farmers indicate that excellent results have been obtained by seed inoculation prior to planting, but a number of failures have also occurred, particularly with subterranean clover. These, apart from adverse seasonal conditions, have been traced in almost every instance to *faulty sowing methods and particularly to the mixing of inoculated seed with superphosphate prior to planting,* this procedure nullifying the beneficial effect of the bacteria. From both practical and theoretical considerations, therefore, it has been the recommendation of this Department for a number of years that pure-culture-inoculated seed should be sown separately from the superphosphate fertiliser unless the seed and fertiliser were sown immediately after mixing on a wet seed bed (1).

Reid (2) has demonstrated in New Zealand that mixing inoculated lucerne seed with superphosphate before sowing killed the bacteria, but mixing with basic superphosphate produced better results. In Western Australia also, one farmer* with many years' experience in the establishment of subterranean clover, reported that in his district, where inoculated subterranean clover seed has been mixed with basic superphosphate before planting, infinitely better results have been obtained than where superphosphate has been used.

As subterranean clover is destined to play an increasingly important part in developing new areas of land in this State for pasture purposes, and as large numbers of cultures are being supplied by this Department for clover seed inoculation (see Table 1), a more accurate knowledge concerning the influence of sowing methods on effective plant inoculation seemed desirable. An experiment was therefore planned with the following main objects:—

Objects of Experiment.

(1) To test the efficiency of the subterranean clover strain of rhizobial bacteria used by this Department, by comparing the yields obtained from inoculated and uninoculated subterranean clover seed, when planted on virgin soil.

(2) To study the influence of various methods of planting inoculated subterranean clover seed in conjunction with superphosphate, on the subsequent effective plant inoculation, and to determine the best practical sowing methods.

(3) To ascertain whether mixing inoculated subterranean clover seed with superphosphate for various periods prior to planting, is more detrimental than the mixing of inoculated seed with basic superphosphate for the same periods of time.

Details of Experiment.

The experiment was conducted at Ridge Hill in the Helena Valley district of the Darling Ranges on the property of Mr. H. Larwood. The site is adjacent to the metropolitan area, and rainfall figures, taken from the nearest meteorological station, show that the mean annual rainfall is 34 inches.

The monthly precipitation during the course of the experiment was:—

May.	June.	July.	August.	September.	October.	November.	December.	Total.
205	482	639	426	325	202	125	15	2,419

The site was cleared of natural vegetation just prior to commencing the experiment; and with the exception of rhizobial bacteria specific for native legumes (which appear to be ineffective for the inoculation of most agricultural species so far grown in W.A.), the soil in this respect was thought to be completely sterile, being completely surrounded by virgin bush in which, as far as can be learned, stock had never been depastured.

Vegetation.

The vegetation in this area is typical of a large section of the Darling Range country, the dominant tree formation consisting of jarrah (*Eucalyptus marginata*)

* E. Farleigh, Esq., Rylington Park, Boyup Brook.

and marri or red gum (*E. calophylla*), sometimes intermixed with wandoo (*E. redunca* var. *elata*).

The smaller trees and shrubs are mainly represented by sclerophyllous members of the families Proteaceae Leguminoseae (particularly Papilionaceae) and Myrtaceae, together with the blackboy (*Xanthorrhoea Preissii*) and Zamia palm (*Macrozamia Reidlei*).

Soil Type.

The soil is of the podsolic type and typical of large areas of the jarrah and marri belts of the Darling Ranges (Teakle (3)) consisting of ironstone gravelly sands, the surface varying from grey brown to light brown in colour. These soils rest on a yellowish and whitish to yellowish clay layer at highly variable depths, and at greater depths kaolinised rock material is generally encountered.

The soil of the experimental area contained from 44 per cent. to 75 per cent. of gravel in the surface 3 inches and from 38 per cent. to 69 per cent. gravel in the sub-surface to a depth of 9 inches.

The soil reaction ranged from pH 5.8—pH 6.2 in this surface layer and from pH 5.9—pH 6.2 in the subsurface soil.

Lay Out, Sowing Rates, etc.

The experiment consisting of 11 *treatments was arranged in the form of a randomised block with six separately randomised replications of each treatment.*

Treatment rows were half a chain long and four links apart and each row was hoed out to a depth ot three inches for the subsequent sowing therein of the seed and fertiliser.

The mid-season strain of subterranean clover was used in this experiment, the seed being cleaned but unpolished. The rate of sowing was 8 lbs. per acre.

Superphosphate at the rate of 1½ cwt. per acre and basic superphosphate containing equivalent amounts of phosphoric acid per acre were applied. The superphosphate used contained 23 per cent. total phophoric acid and the basic superphosphate 17 per cent.

The treatments were as follows:—

Treatment.

(1) Superphosphate applied to the soil 48 hours before planting the uninoculated seed.
(2) Superphosphate applied to the soil 48 hours before planting the inoculated seed.
(3) Superphosphate applied and thinly covered with soil, inoculated seed, then planted immediately.
(4) Superphosphate mixed with inoculated seed, then planted immediately.
(5) Superphosphate mixed with inoculated seed and planted after contact for one hour.
(6) Superphosphate mixed with inoculated seed and planted after contact for 24 hours.
(7) Superphosphate mixed with inoculated seed and planted after contact for 48 hours.
(8) Basic superphosphate mixed with inoculated seed and planted after contact for 1 hour.
(9) Basic superphosphate mixed with inoculated seed and planted after contact for 24 hours.
(10) Basic superphosphate mixed with inoculated seed and planted after contact for 48 hours.
(11) Superphosphate applied to the soil, and seed inoculated, 48 hours before planting.
Planting of seed withheld until all other treatment plantings were completed.

The treatments were designed to represent the common methods used in practice of sowing inoculated subterranean clover seed in conjunction with phosphatic fertiliser.

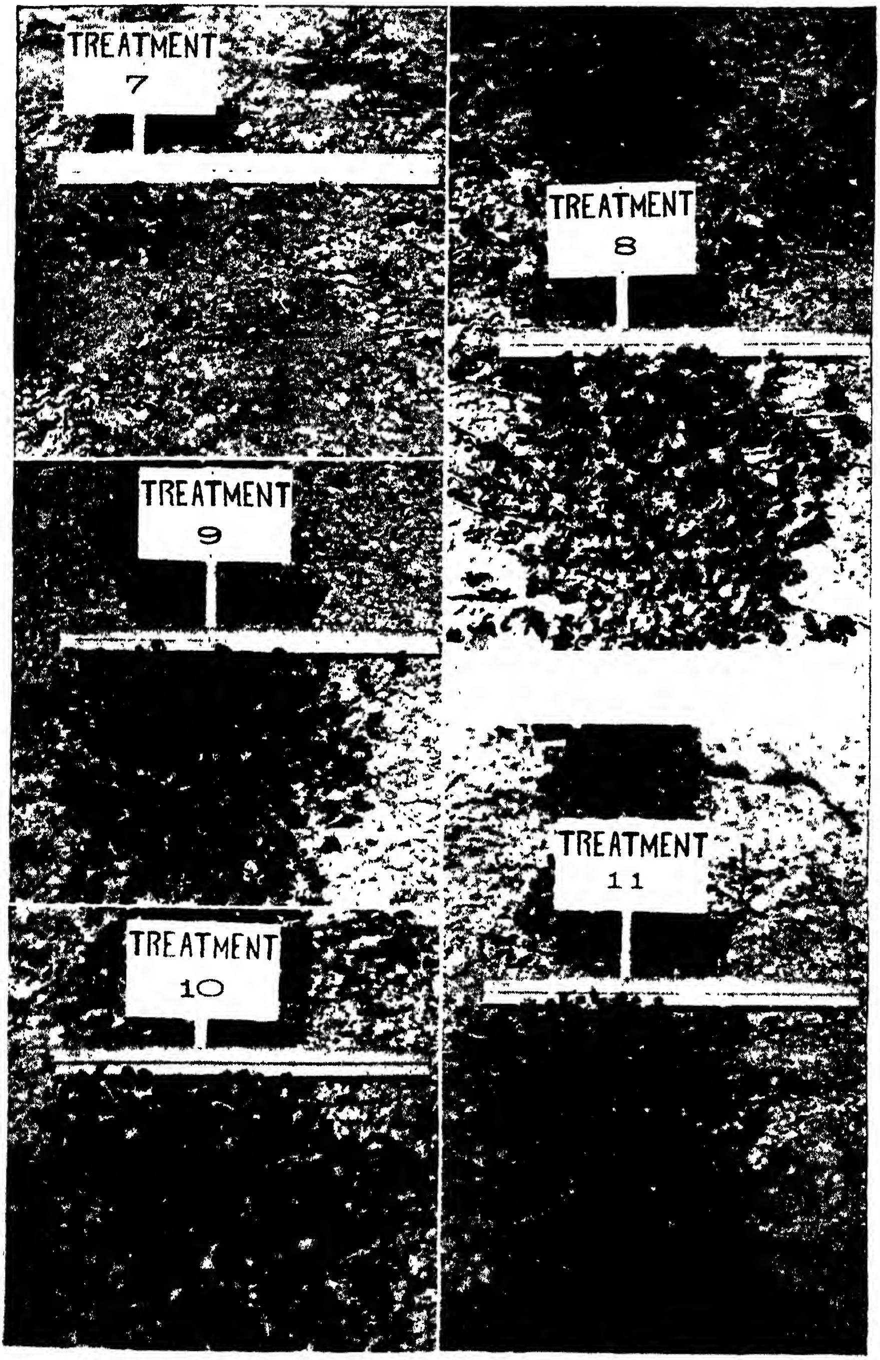
PLATE 1

Variations in the growth of Subterranean Clover illustrating the influence of planting methods in conjunction with superphosphate fertiliser on the effective inoculation obtained.

For details of treatments 1-6 see page 63.

PLATE 2.

Variations in the growth of Subterranean Clover illustrating the influence of planting methods in conjunction with superphosphate and basic superphosphate fertilisers on the effective inoculation obtained.



For details of treatments 7-11 see page 63.

An analysis of these methods shows that they can be divided into two main groups—

(1) Those in which the fertiliser does not make contact with the seed before planting.

(2) Those in which the seed and fertiliser are in contact for various periods prior to planting.

In group (1) may be placed the method in which the fertiliser is separately applied some time before the seed is planted (represented by treatments 1, 2, and 11) and the method of sowing with the "small seeds" attachment to the ordinary grain and fertiliser drill. In this method, as commonly used in W.A., the superphosphate is first covered with soil by the drill tynes, and the seed is harrowed in above the fertiliser (represented by treatment 3).

In group (2) may be placed the following methods: (a) Seed and super. sown in one operation but through separate sides of the drill box, as for example when planting subterranean clover seed mixed with the seed of a cover crop. In this method the seed comes into *momentary contact only* with the superphosphate in the drill tubes before it is planted in the soil. (Represented by treatment 4.)

(b) Mixing the seed with superphosphate for various periods before either broadcasting or sowing through the superphosphate box of the drill (represented by treatments 5, 6, and 7), or, with basic superphosphate (represented by treatments 8, 9 and 10).

With the exception of treatments 1 and 11, all seed was inoculated just prior to planting, or mixing with the fertilisers (the method of inoculation used being strictly according to departmental recommendations (1)) and the seed was perfectly dry when either mixed with fertiliser or sown. In all treatments where the inoculated seed was mixed with fertiliser before planting, the seed for each treatment row was mixed in every case with the full amount of fertiliser to be used in that row.

The seed for treatment 11 was inoculated 48 hours before being planted after all other treatments.

Treatments 1, 2, 3, 4, 5, and 8 were planted on 23/6/38; treatments 6 and 9 were planted 24 hours later, and treatments 7, 10, and 11 on 25/6/38, some 48 hours later.

All seed was covered with soil immediately after planting, the sowing depth being as near as possible to half an inch.

RESULTS.

The germination throughout was excellent and in spite of very careful observations, no differences in plant numbers could be detected in any particular treatments. Within a month of germination, however, the growth in treatments 1, 6, and 7 was obviously inferior to the remainder, and subsequently many of these plants, showing symptoms of nitrogen starvation as indicated by their reddish-yellow foliage and stunted habit of growth, died out.

By the end of August the harmful effect of mixing the inoculated seed with superphosphate prior to planting was seen to be related to the time of contact. Whereas the growth of treatment 4 was excellent, treatment 5 was somewhat inferior and the growth of treatments 6 and 7 appeared little better than treatment 1 in which the seed was not inoculated.

On the other hand, the growth of treatments 8, 9, and 10 in which the inoculated seed was mixed with basic superphosphate prior to planting, was striking by comparison; no differences could be observed and all were uniformly good.

On 7th September, 1938, this experiment was inspected by Dr. A. E. V. Richardson, Deputy Chief Executive Officer, C.S.I.R., Melbourne, Victoria, Professor J. E. Nichols, Professor of Agriculture in the University of Western Australia, and a number of officers from the Agricultural Department, W.A.

Without any knowledge of the randomised layout of the different treatments, Nos. 1, 6, and 7 were unerringly chosen as the most inferior in each of the six blocks. Opinions differed regarding the best treatment, as Nos. 3, 4, 8, 9, and 10 all appeared to be equally good.

During October a few plants in treatments 6 and 7 made better progress, being aided, it was thought, by a delayed inoculation, but it was quite evident that because of their very slow growth earlier in the season the amount of seed produced for regeneration by the plants in these treatments would be very limited.

Harvesting commenced on the 25th October, 1938, when flowering generally was completed, and each block was separately harvested by cutting the plants from each treatment at ground level and weighing the total produce of each half chain row.

In order to obtain some idea of the plant survival value of the different treatments, complete plant counts were also made.

Harvesting was completed on the 1st November, 1938, and after all the material had been thoroughly air dried (during which time plant counts were again checked), composite treatment samples were submitted to the Government Analyst for moisture and nitrogen determination.

DETAILED RESULTS.

TABLE 2.

Mean Yields per Treatment half-chain Row (Oven-dried Weights).
(Average of Six Randomised Replications).

Treatment No.	1.	2.	3	4.	5.	6.	7.	8.	9	10.	11.
Actual Mean Yield (gms.)	40·7	161·7	278·3	300·5	217·3	80·8	73·3	355·7	332·7	332·2	213·7
Yield (%)	100	397	684	738	534	198	180	874	817	816	525

P> ·05—Diff for significance = ±58·47 gms.
P> ·05—Diff. for significance = ±144%.

TABLE 3.

Nitrogen Percentages (expresseds on Oven-dried Samples) and Total Yields of Nitrogen per Treatment half-chain Row.

Treatment No.	1.	2.	3	4.	5.	6.	7.	8.	9.	10.	11.
Nitrogen (%)	2·2	2·01	1·97	1·93	2·15	2·22	2·19	2·13	2·28	2·18	2·02
Total Yield of Nitrogen (gms.)	·90	3·25	5·48	5·80	4·67	1·79	1·61	7·58	7·59	7·24	4·32
Total Yield of Nitrogen (%)	100	361	609	644	519	199	179	842	843	804	480

TABLE 4.

Mean Plant Numbers per Treatment half-chain Row.
(Average of Six Randomised Replications).

Treatment No.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
Actual Mean Plant Numbers	174·3	216·0	245·3	223·2	229·3	188·5	161·8	240·6	231·2	235·2	252·0
Plant Numbers (%) ...	100	124	141	128	132	108	93	139	133	135	144

P> ·05—Diff. for significance = ±25·45.
P> ·05—Diff. for significance = ±15%

Discussion of Results.

By comparing the results of treatment 1 (*uninoculated seed*) with those of treatments 2 and 11 (*inoculated seed*) the effectiveness of the strain of rhizobial bacteria used can be established, for the sowing methods in these three treatments were similar.

The fact that the inoculated seed in treatment 11 was kept for 48 hours before planting does not invalidate this comparison, as the bacteria would not be expected to increase on the seed during this period, for the process involved the drying of the seed, by exposure to air, very quickly after inoculation, and furthermore, the mean yields of treatments 2 and 11 were significantly the same.

Reference to the tables of results will show that as a direct result of inoculation the mean yields and total nitrogen content of treatments 2 and 11 were increased approximately four and five times, and the plant survival figures were also significantly higher. The strain of rhizobial bacteria used was therefore highly effective.

Referring to the second object of the experiment, it will be seen from tables 2 and 3 that planting methods have considerably influenced the yield. *The best treatments for sowing inoculated seed in conjunction with superphosphate were those in which the seed and superphosphate were sown at the same time, but when no contact between them was made or the contact prior to planting was of very short duration.* Thus the mean yields of treatments 3 (representing the "small seeds" attachment) and 4 (representing the sowing of the seed and fertiliser through separate sides of the drill box) were significantly higher than the remaining sowing methods in which superphosphate was the fertiliser used. The total yield of nitrogen per treatment was also raised considerably by these methods of planting.

Where the superphosphate was separately applied 48 hours before planting (treatments 2 and 11) the yields were significantly lower than treatments 3 and 4. and significantly the same as treatment 5, in which the inoculated seed was in contact with the superphosphate for one hour prior to planting.

The yields of treatments 2 and 11 were lower than expected for it was not anticipated that the method of planting would exert any harmful effect directly on the bacteria.

Although the inoculated seed was planted in contact with the superphosphate (which had been applied 48 hours previously to the soil), the detrimental effect on the bacteria, would, it was thought, be no greater than in treatment 4 where contact between seed and superphosphate was momentary only, before planting.

In view of the soil type and its reaction, and especially as the soil had received heavy rain, and was moist in every case before the seed was planted, it seems more probable that the comparatively low yields obtained in treatments 2 and 11 were caused by the reversion of the applied phosphate to unavailable iron compounds in the soil; and as treatment 5 gave significantly the same yield, in spite of a considerable loss in effectiveness of the inoculation (compare the yield and total nitrogen of treatment 5 with 4) this explanation is further supported.

It is now well recognised that high levels of phosphate in the soil are important not only for plant growth but for the multiplication of the rhizobial bacteria, and hence in these treatments, if the applied phosphate was converted largely into unavailable compounds, plant development would be retarded by both lack of available phosphate and poorer nodulation due to the inability of the rhizobial bacteria to multiply in the soil.

The detrimental effect of mixing inoculated seed with superphosphate for periods of 1, 24 and 48 hours prior to planting, was strikingly illustrated in this

experiment. Significant reductions in yield were obtained for the first and second periods, whereas at the end of 48 hours, little further reduction resulted. The total yields of nitrogen and plant survival numbers were also lower in treatments 6 and 7 than in any other treatments in which the inoculated seed was sown in conjunction with superphosphate.

In order that these results should not be criticised on the grounds that reduction in yield had been brought about by the detrimental action of the superphosphate on the germination, rather than on the bacteria, a sample of subterranean clover seed retained from this experiment was tested for germination after being mixed with superphosphate (23 per cent. total phosphoric acid content) and basic superphosphate (17 per cent. total phosphoric acid content) for various periods (4).

The moisture content of the superphosphate (1.6 per cent.) and basic superphosphate (1.63 per cent.) used for germination study, was very similar to that used in this experiment, namely 1.84 per cent. and 1.3 per cent. respectively.

TABLE 5.

Germination of Sample of Subterranean Clover (Low Hard-seed content) after Mixing with Superphosphate and Basic Superphosphate for various periods.

Treatment.	Period of Treatment.	Germination (%).				Hard Seeds.
		10 days.	11 21 days.	Semi-hard.	Total.	
Superphosphate	4 hours	75	6	5	86	2
Do	8 ,,	91	2	0	93	1
Do	24 ,,	79	2	2	83	0
Do	2 days	89	1	5	95	2
Do	3 ,,	96	1	0	97	0
Do	7 ,,	87	4	0	91	3
Do.	14 ,,	78	1	2	81	0
Control		82	4	3	89	3
Basic Superphosphate	4 hours	88	2	1	91	1
Do. do.	8 ,,	71	0	12	83	4
Do. do.	24 ,,	90	0	1	91	1
Do. do.	2 days	86	0	6	92	1
Do do.	3 ,,	55	13	19	87	3
Do. do.	7 ,,	87	4	3	94	3
Do do	11 ,,	88	0	0	88	5

The germination test shows that mixing subterranean clover seed (of low hard seed content) with superphosphate and basic superphosphate of low moisture content for up to fourteen days did not materially affect the germination. A second test carried out with a sample of seed of high hard seed content gave similar results.

A further criticism that the bacteria present on the seed would, even if not mixed with fertiliser, normally lose their effectiveness for inoculation during similar periods of 1, 24 and 48 hours, can be disproved by comparing the yield of treatment 11 with treatment 2.

After inoculation the seed for treatment 2 was planted as soon as possible, whereas the seed for treatment 11 was held for 48 hours after inoculation before being planted by a similar method; yet the yield of each was significantly the same.

It is thus evident that the reduction in yield in treatments 5, 6 and 7 was solely brought about by the harmful action of the superphosphate on the bacteria as the result of mixing the inoculated seed with superphosphate for periods of 1, 24 and 48 hours prior to planting; but whether the superphosphate directly injures the bacteria by disinfection, or merely impairs them in some way for effective inoculation, is not yet definitely known.

Taking the difference in yield between treatment 4 and treatment 5 as a basis for calculating the loss of viable bacteria during 1 hour, a normal disinfection curve can be constructed, with numbers of bacteria regarded as the ordinates, plotted against the disinfection times as abscissas.

Such a curve is shown in Fig. 1 and it is of interest to note that the values for yield obtained in this experiment for treatments 6 and 7 where the inoculated seed had been exposed to the harmful action of superphosphate for 24 and 48 hours respectively, lie close to the theoretical curve. This strongly suggests that superphosphate when mixed with inoculated seed prior to planting kills the rhizo-

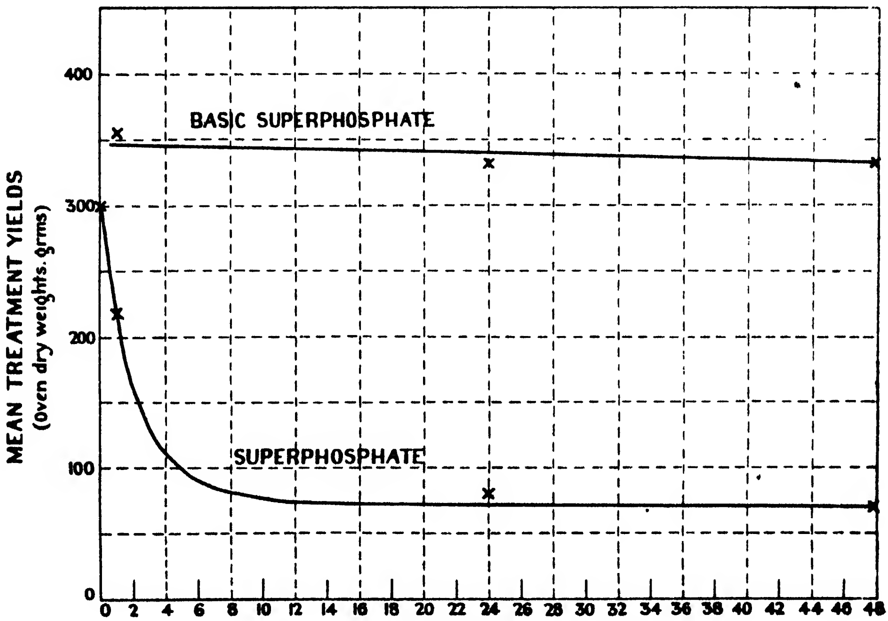


Fig 1.

bial bacteria by disinfection but a laboratory study by means of plate counts must be undertaken to prove that this is so. Plant survivals and total nitrogen per treatment were also reduced as a result of mixing the inoculated seed with superphosphate for 24 and 48 hours.

These results indicate in a very emphatic manner how easily the beneficial effects of inoculation may be nullified by mixing pure-culture treated seed with superphosphate prior to planting.

As compared with superphosphate, basic superphosphate does little damage to the bacteria, even after a period of contact for 48 hours; for all the basic superphosphate treatments (8, 9 *and* 10) *gave significantly the same yield* (*see Table* 2 *and Fig.* 1).

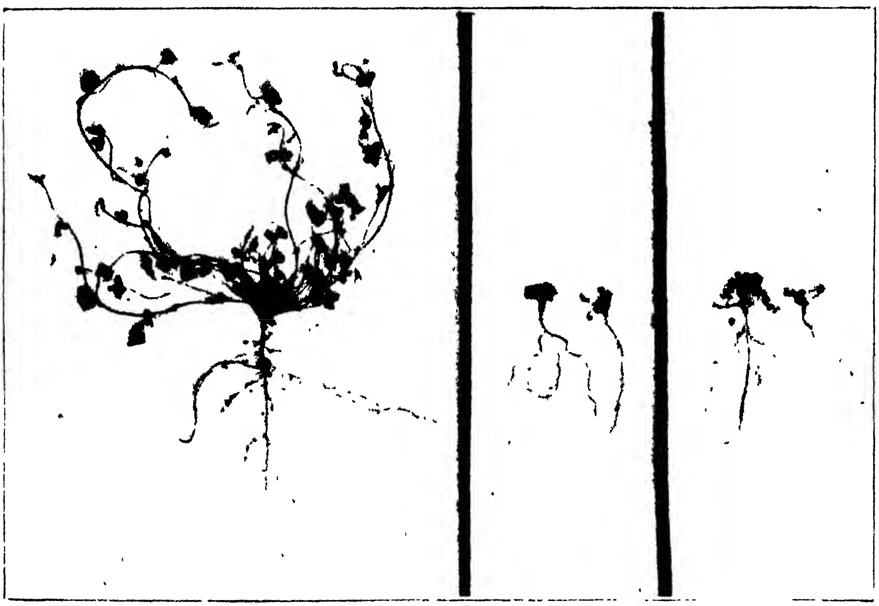
In spite of this however none of the basic superphosphate treatments were significantly higher than treatment 4, the best superphosphate treatment in which the inoculated seed was mixed with superphosphate and sown immediately, for the effective inoculation was not nullified by this momentary period of contact.

While harvesting was in progress numbers of plant roots were carefully examined for the occurrence and location of nodules.

As numerous workers have reported (5, 6, 7 and 8) that in general good strains of rhizobial bacteria produce large nodules located on the top portion of the root, while poorer strains produce many small nodules on the lateral rootlets, it is of interest to record that in this experiment where the same highly effective strain of bacteria was used to inoculate the seed, different types of nodules were produced by the plants in different treatments. The plants examined in treatment 10 (inoculated seed mixed with basic superphosphate for 48 hours before sowing) each possessed a few large nodules on the upper portions of their tap roots, while those in treatment 7 (inoculated seed mixed with superphosphate for a similar period prior to sowing), in which delayed inoculation had occurred in the late spring, possessed very small nodules on their lateral rootlets only, and on the roots of the uninoculated plants in treatment 1 nodules were almost entirely absent. (See plate 3.)

PLATE 3.

Variations in nodule size and placing produced by different treatments.



a. b c.

(a) Plant from treatment 10 (inoculated seed mixed with basic superphosphate for 48 hours before planting), showing large nodules on upper portion of tap root.

(b) Plants grown from uninoculated seed (treatment 1), showing absence of nodules.

(c) Plants from treatment 7 (inoculated seed mixed with superphosphate for 48 hours before planting), showing small nodules confined to lateral roots.

In view of the general absence of nodules on the uninoculated plants, and the isolated nature of the site on which this experiment was conducted, it is unlikely that the plants in treatment 7 were inoculated after planting by rhizobial bacteria previously present in the soil, rather than by those introduced with the inoculated seed.

In this experiment it is thought, therefore, that *large nodules* on the upper portions of the tap roots of the plants in treatment 10 did not merely indicate the effectiveness of the strain of bacteria used, *but the early inoculation of these plants*

also, as a result of the introduction to the soil of large numbers of bacteria, which survived on the inoculated seed during this method of planting.

However, the possibility should be borne in mind, that the delayed inoculation of the plants in treatment 7 was brought about not only by the reduction in numbers of viable bacteria on the surface of the inoculated seed, but also by the harmful action of the superphosphate, which so injured the bacteria that physiologically they were converted into a less effective strain capable of producing nodules on the lateral roots only.

Recommendations for Sowing Subterranean Clover Seed to Ensure the Maximum Advantage from Seed Inoculation.

The results of this experiment indicate in a very striking manner the influence of sowing methods on effective plant inoculation.

A.—Wet Sowing.

1. *To ensure the maximum advantage from artificial seed inoculation the seed should not be mixed with superphosphate before planting, as superphosphate injures the bacteria.* With this object in view the best practical methods of sowing are those in which the inoculated seed is planted at the same time as the superphosphate fertiliser, but when no contact is made, or the contact between them is momentary only.

2. (a) Planting the inoculated seed by means of a special "small seeds" attachment to the ordinary grain and fertiliser drill, followed by light harrows; or (b) planting through separate sides of the drill box as, for example, when sowing with a light cover crop, are satisfactory methods. (In these or in any other methods the need for planting at the correct depth of ½ inch and no deeper than one inch should be borne in mind as experiments have shown that the germination may be adversely affected by too deep sowing (9). Also in districts of limited rainfall the cover crop may adversely affect the growth of the clover by competition for soil moisture.)

3. The application of superphosphate some time in advance of sowing the seed is unnecessary but if more convenient to the requirements of farm practice, it will yield fair results.

4. If for any reason the inoculated seed must be mixed with superphosphate, for either planting through the super box of the drill or for broadcasting, both inoculated seed and super should be dry, and it is strongly recommended that only a limited quantity be mixed at a time, so that the mixture can be sown within half an hour.

5. On ironstone soils where reversion is likely to occur, basic superphosphate offers possibilities, but whether (in view of its greater price and its lower total phosphoric acid content) it will prove more profitable than larger applications of superphosphate of the same monetary value is yet to be determined.

Where basic superphosphate is the fertiliser used the dry inoculated seed and fertiliser may be mixed together and the mixture should be sown within 12 hours.

B.—Dry Sowing.

The above recommendations are made for sowing under wet seedbed conditions as it is thought that any detrimental effect caused by contact between the inoculated seed and fertiliser when planting, would be further prolonged subsequently in dry soil.

6. For this reason when planting in dry soil is unavoidable, it is believed that the methods suggested in Recommendations 2 (a) or 3 will prove most suitable.

SUMMARY OF EXPERIMENT (1).

The inoculation of subterranean clover seed with an effective strain of rhizobial bacteria (*Rhizobium trifolii*) prior to planting, has materially increased the yield, total nitrogen content, and plant survival number. The methods of sowing inoculated subterranean clover seed, in conjunction with superphosphate (on new land under wet seedbed conditions), considerably influence the effective plant inoculation, and hence the yield.

Under these conditions the best practical methods of sowing are those in which the inoculated seed is planted at the same time as the superphosphate fertiliser but when no contact is made, or the contact between them is momentary only, and takes place just prior to seed and fertiliser reaching the moist soil.

Mixing inoculated subterranean clover seed with superphosphate (23 per cent. total phosphoric acid content) for periods of 1, 24 and 48 hours before planting is injurious to the bacteria, resulting in less effective plant inoculation, significant reduction in yield, and in plant survivals (for the two longest periods). Mixing inoculated seed with basic superphosphate (17 per cent. total phosphoric acid content), for similar periods before planting is not harmful to the bacteria as the yields remain significantly the same. Variations in both nodule size and placing were produced by mixing inoculated seed with superphosphate and basic superphosphate for periods of 48 hours before planting. These variations may either be related to the influence of these methods of planting on the numbers of viable bacteria introduced with the inoculated seed to the soil, or to a physiological change in the effectiveness of the strain of bacteria as a result of fertiliser injury, or to a combination of both of these factors.

As the result of this experiment, practical recommendations for sowing inoculated subterranean clover seed in conjunction with superphosphate and basic superphosphate are made.

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THE EFFECT OF INOCULATION ON THE GROWTH OF FIELD PEAS, LUCERNE, LUPINS, AND TICK BEANS.

Inoculation Experiments, 1938.

Experiment 2.

By reference to table 1 (Experiment 1) it will be seen that there is a considerable demand from farmers for bacterial cultures for the inoculation before planting, of Pea, Lucerne and Lupin seed, in addition to subterranean clover. The bacteria required for the inoculation of each of these legumes form distinct strains,

and thus the strain of rhizobial bacteria effective with peas is ineffective with lucerne, or lupin, and vice versa.

Each strain of the bacteria will serve to inoculate a group of closely related plants (cross inoculation group), but it is now well recognised that the inoculation obtained with all plant species in this group may vary considerably in effectiveness. For various reasons opportunities for the carrying out of Departmental experiments to demonstrate the advantages resulting from pure-culture seed-inoculation have in the past been limited, but many reports of excellent results received from farmers have left no doubt about this matter, where the instructions forwarded with the cultures have been carefully followed.

Objects of Experiment.

As some strains of rhizobial bacteria supplied by this Department have now been propagated continuously in pure culture for a number of years, it was considered advisable at this stage to test their effectiveness under field conditions by comparing the yields obtained from inoculated and uninoculated seed.

The strains chosen for test were those which have been in greatest demand, namely the pea, lucerne and lupin strains.

The varieties used in the experiment were the White Brunswick Field Pea, Bell Windsor Tick Bean, Hunter River Lucerne and W.A. Blue Lupin. Tick Beans are included in the group of plants which are considered to be effectively inoculated by the pea strain of bacteria and as (being immune to the pea weevil, *Bruchus Pisorum* (linn)) they have been increasingly planted for green manuring and other purposes, since this pest became widespread in W.A., further information concerning this point was desired.

The experiment was conducted at Ridge Hill (on a site adjoining that mentioned in Experiment 1), and at Forrest Field on the property of Mr. T. Maher, the layout in each case being identical.

The Forrest Field property is also situated in the Darling Ranges but some few miles from Ridge Hill, and details concerning rainfall, soil and vegetation are therefore similar to those described in Experiment 1.

Details of Experiment.

Each variety was sown in rows half a chain long and four links apart, alternate rows being planted with inoculated and uninoculated seed, and each treatment was replicated six times. Each row was hoed out to a depth of three inches and superphosphate at the rate of 1½ cwts. per acre was placed in the trenches so formed, some 48 hours before planting the seed.

The uninoculated seed of each variety was sown first in all the rows involved, followed immediately by the inoculated seed in all the remaining rows.

Seed for the inoculated rows was treated with a suspension of the appropriate bacteria in skim milk, before planting in accordance with Departmental recommendations (1).

The rates of sowing were lucerne 10 lbs. per acre, tick beans, peas and lupins 132 seeds per ½ chain row. At Forrest Field the planting was carried out on the 3rd and 4th June, and at Ridge Hill, on the 22nd and 24th June, 1938.

The depth of planting was approximately ¾-inch for the lucerne and 2-inch for the remaining legumes.

At both places the germination of the lucerne, peas and tick beans was excellent and no difference in favour of either the inoculated or control rows could be noted. By comparison the germination of the lupins was extremely uneven throughout. Within a month of planting, the inoculated rows of peas and lucerne showed a marked superiority in growth over the controls and in colour they were a deeper green.

PLATE 4.

Inoculated and Uninoculated Lucerne grown at Forrest Field.

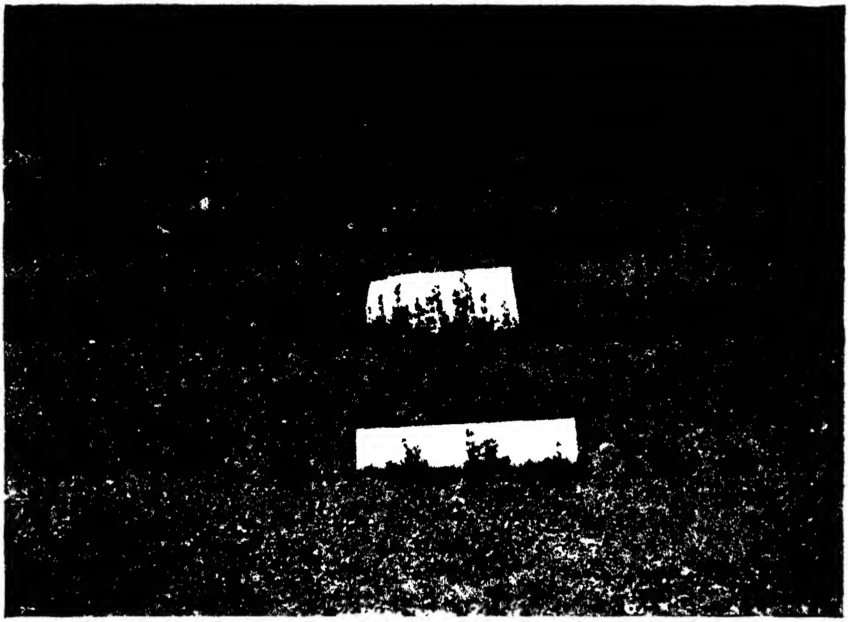

Fig 2.

Fig. 3.

Fig. 2.—Plants in foreground grown from uninoculated seed. Plants in second row grown from inoculated seed.

Fig. 3.—Plants in centre row grown from uninoculated seed. Plants in alternate rows grown from inoculated seed.

The increase in the green yield in favour of inoculation amounted to 117 per cent.

At the Forrest Field site this difference in the growth of the inoculated peas became less marked as time went on, due apparently to the delayed inoculation of the controls with bacteria present in the soil.

At no stage during the experiment could any difference be detected between the inoculated and control rows of tick beans and lupins.

In view of the late planting, the lupins made quite satisfactory growth, but with the exception of a few plants in either treatment the tick beans were stunted.

The marked superiority of the inoculated rows of lucerne at both sites, and of the peas at Ridge Hill, was maintained throughout the experiment.

Harvesting was carried out on the following dates when the lucerne was in flower and the majority of the pods of lupins, peas and tick beans contained half grown seed.

	Forrest Field.	Ridge Hill.
Peas	9/9/38	26/9/38
Lucerne	10/11/38	10/11/38
Lupin	10/11/38	10/11/38
Tick Beans	10/11/38	

The tick beans at Ridge Hill were not harvested owing to the poor growth they had made.

Discussion of Results. (See Table 6, page 78.)

Although both sites were cleared of native vegetation shortly before the experiment commenced the soil at Forrest Field could not be considered truly virgin as regards its content of rhizobial bacteria necessary for the inoculation of the common agricultural legumes. As it was situated only a few yards from the boundary of an orchard in which inoculated legumes had previously been grown, and at a lower level, it was subject to considerable bacterial contamination by rain-washed and wind-blown soil.

Despite this fact *the increase in the green yield of lucerne in favour of inoculation was considerable, amounting to* 117 *per cent.* (see Plate 4, Figs. 2 and 3) and 49 per cent. in the case of peas. At Ridge Hill, on the other hand, except for rhizobial bacteria specific for native species of plants, which appear to be ineffective for the nodulation of agricultural legumes, the soil in this respect was thought to be completely sterile. At this place the contrast between the inoculated and uninoculated rows of peas and lucerne was very marked, *the uninoculated peas being a complete failure, whereas the inoculated plants which were sturdy and healthy, yielded more than eleven times the green weights of the controls* (see Plate 5, Figs. 4 and 5), while *the inoculated lucerne yielded nearly four times the weight of the controls.*

At neither site were significant increases in yield obtained by artificial inoculation of the lupin seed, but this was almost certainly due to the inoculation of the controls with bacteria, either in the soil adhering to the seed (with which they were heavily coated) or in the soil in which they were planted, rather than to the use of an ineffective strain. A careful examination of the roots of plants taken from *both* the *inoculated* and *control rows* showed that all carried the bacterial nodules on their tap roots.

The tick beans, even after allowing for the late planting, made disappointing growth at both situations, and the majority of the roots of plants taken from both inoculated and uninoculated rows showed no evidence of nodulation.

As reported elsewhere (2) the pea strain of rhizobial bacteria used in this experiment for the inoculation of tick beans does not appear to be equally effective with all plant species of the cross inoculation group, and it is apparent, therefore, that a new strain must be procured for the successful inoculation of this legume.

PLATE 5.

Inoculated and Uninoculated Field Peas grown at Ridge Hill.

Fig. 4.

Fig. 5.

Fig. 4.—Plants in foreground grown from uninoculated seed. Plants in second row grown from inoculated seed.

Fig. 5.—Plants in centre row grown from inoculated seed. Plants in alternate rows grown from uninoculated seed.

The increase in the green yield in favour of inoculation amounted to 1,021 per cent.

TABLE 6.

Legume.	Forrest Field.				Ridge Hill.			
	Green Yields (Total of 6 half-chain rows).		Green Yields (Percentage).	Nitrogen (Percentage on Dry Basis).	Green Yields (Total of 6 half-chain rows).		Green Yields (Percentage).	Nitrogen (Percentage on Dry Basis).
	Uninoculated.	Inoculated.			Uninoculated.	Inoculated.		
	lbs. ozs.	lbs. ozs.			lbs. ozs.	lbs. ozs.		
Field Pea	23 4½	...	100	2·24	4 3½	...	100	2·25
	...	33 15¼	149	2·88	...	47 4¾	1121	2·96
Lucerne	4 1	...	100	2·02	2 4¼	...	100	1·89
	...	8 13	217	2·52	...	8 10½	382	2·30
Lupin	27 9¼	...	100	...	21 8½	...	100	1·89
	...	27 15	101	...	...	22 4¼	103	3·83
Tick Bean	16 6¼	...	100	2·17	Not harvested owing to unsatisfactory growth.			
	...	16 11¼	102	2·12				

For this reason isolations from nodules obtained from healthy tick bean plants will be made in the Plant Pathological Laboratory and it is hoped that the new strain will be available for testing during the forthcoming planting season.

Although the percentage differences in nitrogen content in favour of inoculation were in general not very marked yet, taking into account the extra green weight produced where effective nodulation was secured, the increase in the total yield of nitrogen was considerable.

SUMMARY AND CONCLUSIONS (EXPERIMENT 2).

An experiment to test the effectiveness of the pea, lucerne and lupin strains of rhizobial bacteria is described.

Large increases in the yield of peas and lucerne have been obtained by artificial seed inoculation with the requisite strains of rhizobial bacteria.

In soil where the requisite bacteria do not already exist, artificial inoculation of these legumes, will (provided other growth factors are satisfactory) make all the difference between success or failure of the resulting crop, as the bacteria are apparently carried to only a very limited extent on the seed itself by natural means.

In soil where the bacteria are to some extent already present, less spectacular differences in yield may be expected, nevertheless it is considered that here also artificial seed inoculation of peas and lucerne is still warranted. Although no significant increase in the green yields of lupins was obtained by artificial seed inoculation it is confidently believed that this was due to accidental inoculation of the controls with bacteria present in the soil adhering to the seed, rather than to the use of a defective strain.

For the inoculation of tick beans the pea strain of rhizobial bacteria is ineffective and a strain specific to this legume will be procured for this purpose.

ACKNOWLEDGMENTS.

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During the course of this investigation, advantage was taken on several occasions of the specialised knowledge freely offered, of a number of Departmental officers.

The authors gratefully acknowledge this assistance and our thanks are especially given to Dr. L. J. H. Teakle (Plant Nutrition Officer) for his description of the soil types and the determination of the soil reactions, to Mr. G. R. W. Meadly (Acting Government Botanist) for carrying out the germination studies, to Mr. S. L. Kessell (Conservator of Forests) for making available the services of his Statistical Branch for the purpose of checking and assisting with the statistical analysis of the results, and to others who assisted in the matter of transport.

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THE FEEDING OF POULTRY ON WHEAT AND OTHER GRAINS.

"Fowls Cannot Lay on Wheat Alone."

In a previous article we discussed the feeding of poultry by utilising the feeds most commonly used, not only by the commercial poultry farmer, but also by those farmers who were able to procure bran and pollard at reasonable rates. It is evident that, in some districts, the farmer has had perforce to use the product of the farm, and, in most cases, although he has a supply of bran and pollard when he sends grain to the mills for milling into flour for his own use, the supply is restricted, and is in some cases negligible for practical purposes. In other cases it is well nigh impossible to obtain even the means of grinding the grain, and the farmer imports his flour requirements.

In both instances the farmer is bound to use a diet which is based on the grain in its many forms—whole, gristed, boiled, or soaked. It is for these farmers that this article is written.

We have heard of the several ways of using the grain. Some methods are open to question, while others are admirable. When we are to discuss the feeding of poultry, we must understand the principles of feeding and the feeds used. We have proteins, we have carbohydrates, we have fibre, minerals and also vitamins. All are wanted and all must be so incorporated in the rations that the birds will neither be starved nor restricted in the supply of any particular form of food, or, put in another way, they will be obtaining the correct balance of all requirements. Any shortage of one or the other will show up in the egg production of the layers, the poor growth of the birds which are to be kept for flesh production, and also in the tendency of all the flock to be weakened in constitution.

Briefly speaking, all foods must contain the following constituents:—

Proteins—those parts of the food which are used by the bird to make body, eggs and feathers.

Carbohydrates—those portions of the food which provide the driving force which assists the birds to convert the proteins into body, eggs and feathers.

Fibre—the portions which provide the bulk and aid digestion.

Vitamins—complicated elements necessary to growth.

Minerals—for the bone, body and egg formation.

Moisture—a necessary adjunct to all matter.

Roughly, the above are the necessary ingredients of all poultry feeds and all must be present in the ration in the right proportions.

When we are considering the feeding on the farms we will have—

Bran in restricted quantities;

Pollard, also in restricted amounts;

Cereals such as wheat, oats and in some cases, barley;

Animal foods such as the rabbit, the sheep, the kangaroo, and the milk, either skimmed or separated.

The feeding values of foodstuffs is determined by the percentage of the various components, such as—

Proteins
Carbohydrates
Fats and oils
Minerals
Fibre and moisture.

Protein is a nitrogen-containing food element used for flesh-forming, the building up of waste tissue, and most essential for egg production.

Carbohydrates are made up largely of starch, sugars, gums, etc., which produce heat and energy and form body fats.

Ash is the residue of burnt up foods and contains the minerals necessary for development of bone and feathers, and the formation of egg shell.

Fibre is the outer cells of grains and the fibrous matter in plants, and is not digestible; but a percentage is always present and is necessary to assist digestion.

Moisture in varying proportions is found in all foodstuffs.

Protein is the most expensive ingredient of any feed. It will produce heat and energy, but as a source of heat and energy is too expensive. We therefore concentrate on other ingredients high in carbohydrates and fats when we desire our energy-forming foods. Let us examine the foods for protein and carbohydrates.

Wheat and oats contain approximately 1 part protein, 7 parts carbohydrate, 12 per cent. moisture.

Bran and barley contain approximately 1 part protein, 5 parts carbohydrate, 8 per cent. moisture.

Pollard contains approximately 1 part protein, 6 parts carbohydrate, 9 per cent. moisture.

Skimmed and separated milk contain 1 part protein, 2 parts carbohydrate, 88 per cent. moisture.

Dried Butter Milk contains approximately 2 parts protein, 3 parts carbohydrate, 9 per cent. moisture.

Meatmeal contains approximately 2 parts protein, 1 part carbohydrate, 9 per cent. moisture.

Fresh meat contains approximately 1 part protein, 1½ parts carbohydrate, 67 per cent. moisture.

In order to have a balanced ration, we are expected to arrange the proportions of the feeds so that the ratio between the proteins and the carbohydrates is at 1 to 4.5 or 1 to 5. These figures are used only as a guide, but they are near enough for our purpose.

It will be noticed that in no case are the foods balanced in such a way that they could be efficiently fed to poultry unless mixed with some other ingredients. Therefore we are forced to ascertain the correct amounts of each and every ingredient incorporated so that we are able to obtain the correct balance of 1 to 4.5 or 1 to 5.

If the ration is so constituted that it contains one part protein to less than 4.5 carbohydrates, the ration is said to be "narrow."

If the proportion is greater than one part of protein to five parts of carbohydrates the ration is said to be "wide."

It will be noticed that wheat is "wide," but bran is nevertheless nearly balanced. However, bran is useless when fed alone owing to its bulky nature; yet it is very valuable when used as an essential ingredient, giving a vegetable protein. Pollard is "wide," milk is "narrow," and the meatmeal exceptionally so. Hence we balance the rations of wheat, bran, pollard, etc., and adding the highly concentrated protein foods (milk and meatmeal) in such a way as to ensure palatability and nutriment sufficient for growth, repair of waste tissues, energy and eggs.

When considering any ration we must concentrate on the dry ingredient basis for all calculations. Moisture is not feed in the true sense. Water is essential, but we must never consider it when talking of feed and feeding values.

Wheat Feeding.—It is the practice of some farmers to feed the birds on wheat alone, giving the grain both morning and evening. At times the rabbits and milk are incorporated in the ration.

When one feeds wheat solely either as whole, soaked, boiled or gristed, the ration is known as "wide," that is, the ratio is greater than the 1 to 4.5 or 5 and the wide ration will make the birds fat. On the other hand, if the food were to be made up solely from meatmeal, the ration would be "narrow" and the birds would quickly fade away, but the correct amounts of two feeds incorporated in the mash will give you the desired balance. It will then be readily understood that the farmer will in every case find it necessary to purchase the meatmeal.

Certainly use all the native animal food possible, but the high moisture content of those meats will not allow of sufficient protein in the ration to balance the ration.

Amount of Food Necessary.—The average ration for a bird is 4 oz. per day of dry matter.

When analysing that statement of 4 oz., it must be understood that it also means an average producer and, as the average production is around 130 eggs, and as "you put into the bird what you want, etc," how can a producer of 230 eggs lay that number if you only give her an average ration?

A four-gallon kerosene tin will hold about 50 to 60 ration of wet mash for your stock. One can assume that the birds are intelligent enough to know that they can get no more until the grain feed in the afternoon and so they eat all they can, both the small producer and the high producer. The small producer cannot use all the egg-forming ration to advantage, so it is lost. The large producer does not get enough. Now place in front of the same birds a dry mash hopper and study the trap nests. It will be found first of all that the kerosene tin will feed 100 rations in the morning and all will be content. When registering the trap nests and watching the birds when released, you find the solution to feeding the high producer.

When released from the trap nest, the high producer rushes (no other word for it) to the hopper, while the low producer casually goes outside the shed, finds a convenient hole and settles down, which proves that the high producer must get more feed than the low producer, and that a kerosene tin to 100 is sufficient feed for a low producer.

When feeding at night all will leave the hopper to partake of the grain.

Four ozs. of dry matter also means 2 ozs. of a mixture of bran, pollard, or of wheatmeal, meatmeal, oilcakes, bonemeal at morning and 2 ozs. of wheat at evening.

Measure out 2 ozs. of mash mixture and place it in a well-developed crop and see how little space is occupied. The crop is about half full and anything

half full is hungry, and as a hungry bird is not contented, fill it up with a bulk (green feed), which, besides filling the crop, aids digestion.

Weigh out 2 ozs. of wheat and the same thing occurs—the bird would go to bed hungry. Therefore, fill the crop with green feed fed after the wheat. Besides filling the crop, it again aids digestion. Do not feed more than 2 ozs. wheat with that 2 ozs. mash.

The feeding must be studied in a careful manner. We may certainly give the birds "as much as they will clean up in 20 minutes" and we hand out the wheat as if it does not cost anything.

Wheat Feeding.—It is easily seen that the fowls must have food before them at all times. And the feeding with wheat alone as a grain presents its problems to the farmer. Wheat may be fed as whole grain, soaked grain, and boiled grain.

Whole Grain.—This practice of feeding whole grain at all times should be discouraged. It is a method which does not assist in obtaining the best from the fowls. If the bird is forced to eat whole grain at every meal, the monotony of the diet will affect the quantity eaten by the stock and any restriction in this direction will affect the laying, and also adversely affect the constitution.

It is also difficult in incorporating with the protein requirements, and then the birds will be sure to eat more wheat in proportion to the protein concentrates than is necessary. The feeding of the correct amount of greens will also be well nigh impossible. All wheat feeding is therefore discouraged.

Gristed Wheat.—This form of feeding wheat for incorporation in the morning mash is in direct contrast to whole wheat feeding. It is about the best way of feeding the wheat in the mash. The gristed wheat will "mix" well with the greens and the other ingredients. It will "take" the meatmeal and the bone meal. It provides the base for a palatable mash. It also allows of convenient dry mash feeding. And there are very few farms which are without a grain crusher.

Soaked wheat is for those who are handicapped because of the impossibility of obtaining the gristed wheat, the bran, or the pollard. Soaked wheat provides one of the best methods of providing not only a balanced mash, but also a palatable one. But a word of warning must here be given: Soaked grain swells and it must not be considered that the water incorporated in the swollen grain is a substitute for food. Grain will increase to nearly double its size when soaked, but it will not provide food for double the number of layers.

Boiled Grain.—Boiled grain is extensively used in the farming districts, and this also is an excellent method of providing a base for balanced ration which is also palatable.

Oats and Barley.—These two grains can be fed with success if used in a similar manner to wheat feeding, the only difference being the large proportion of fibre. The extra percentage of fibre must be compensated by giving a larger measure (by weight).

The same principles of feeding are to be applied when one is using grain feeding as one uses when applying pollard and bran and wheatmeal feeding. Balance the ration feed sufficiently and see that the ration is palatable.

FEEDING.

Gristed Wheat.—Gristed wheat without either bran or pollard is fed in the same manner as one would feed if the other foods were available. One must realise that the wheat alone is wider than when mixed with bran, or bran and pollard.

The protein meals to be added will therefore have to be in greater amounts; but this will not materially increase the cost of the ration. The fowl can only consume a certain amount, whether it be all wheat, all meat, or a mixture of both.

Mix the gristed wheat with the chaffed up greens and meat meal and moisten with either the skimmed or separated milk or water. The mash should be crumbly and not wet nor sloppy.

The dry mash for the all-day feeding will be mixed with the same proportions as given for the morning mash. Feed whole grain or even soaked grain for an evening feed.

Use a ration as follows:—

Morning Mash (for all breeds)—Greens, 10 parts by measure; gristed wheat, 5 parts by measure; meat meal, 5/8 part by measure; bone meal, 1/4 part by measure.

Dry Mash (Whites)—Gristed wheat, 5 parts by measure; meat meal, 5/8 part by measure; bone meal, 1/4 part by measure.

Dry Mash (Australs)—Gristed wheat, 5 parts by measure; meat meal, 3/4 part by measure; bone meal, 1/4 part by measure.

Wheat at Evening Meal—Dry: 1½ oz. per bird. Soaked: 1½ oz. (dry weight) per bird; or "by measure" use a 1½ lb. golden syrup or treacle tin to every 15 fowls for dry wheat or to every eight fowls when soaked.

Soaked Wheat Feeding.—The wheat is soaked for 24 hours and then fed to the birds. The methods used are to place the soaked wheat in a trough and mix with the required amount of meat meal and bone meal and this is then fed in troughs to the birds. Do not throw on the ground. Another practice is to make a soup of the meatmeal and soak the grain in the soup.

The portions of wheat to meatmeal is the same as given for gristed grain.

Unless the farmer uses gristed wheat for a dry mash the birds must be fed three times a day so that the farmer is assured they are obtaining all they desire. Care must be taken to see that the meatmeal is carefully regulated.

Boiled Wheat Feeding.—The wheat is boiled and the meatmeal and bone meal are incorporated. The resultant mash is rather sloppy and care must be taken to see that the food does not ferment if left long in the troughs. Again three meals must be given, unless of course, the farmer also grinds grain for a dry mash.

The Feeding of Fresh Meat.—On the farms there is evidence of obtaining fresh meat in some form or other, and one should not neglect to make use of "home grown" product. Rabbits, sheep, calves, kangaroos, all have their place in the ration. One must understand, however, that these sources of food are very high in moisture and therefore allowance must be made for this bulky ingredient.

It has been ascertained that the fowl requires about 1⅜ oz. of lean fresh meat per day in order to meet its requirements in protein. Apart from the cost, the size of that amount of fresh meat will fill the crop and the bird would not be able to obtain sufficient of the other foods necessary for body and egg production. By all means use the fresh meat available, but realise that it is even then necessary to add meatmeal to the ration. The fresh meat available will allow of a small reduction in the amount of meatmeal to be used and therefore reduce the cost of the rations; but meatmeal cannot be eliminated altogether.

Skimmed or Separated Milk.—These two forms of milk are generally available in more or less amounts on any farm, and they should be used in the feeding of the fowls. Again one must remember that these two forms are so much water with a little hard food minerals added. A good gauge is to consider one gallon of milk as equal to one pound of dry milk powders.

Dry Milk Powders.—As dry milk powders are an advantage when feeding poultry, it might not be out of place to mention them in relation to the feeding on the farms in the wheat areas.

The dry powders are the product of the butter factories and are excellent sources of protein. The usual method of feeding dry milk is to reduce the meatmeal by half and add an equal measure of the milk powder, and then ascertain the correct proportion of the meatmeal by watching the colour of the droppings.

But when using the skimmed or separated form, give to the birds all they can consume. Mix the mash with milk, soak the wheat in it or boil the wheat in it.

When the farmer appreciates that the protein is the material which is so essential to the growth of body and eggs and feathers and that the carbohydrates are the energy-forming foods which allow the body to turn the protein into those three factors, it will be evident that there is a definite control over the rations. The proteins cannot be used unless there is something to provide the motive power. Carbohydrates provide that power. If the carbohydrates are not being used to a maximum capacity, the bird has a power of converting the surplus carbohydrates into a reserve and the reserve takes the form of layers of fat. When fat is present the bird has a great reserve at hand to meet any emergency. But that reserve of fat is the tell-tale to the farmer that he is not balancing the rations properly.

Any reserve of fat built up is a definite sign that the bird is not receiving sufficient proteins in the rations. Put another way, the machine has not been supplied with sufficient raw material and is therefore not doing work. It is idling. Supply more proteins and the carbohydrates will have more work to do; more body (to a certain degree) or more eggs will result, and when the bird is in the moult, the feathers will grow quicker. If the correct proteins have been supplied, the carbohydrates will all be used in converting the proteins into the correct channels. And, on the other hand, if too great a proportion of protein is supplied, the machine will be overloaded (as it were) and will run hot. The bird will become run down. Blood spots will form in the eggs. The body will be weakened and eventually a prolapse will occur.

You therefore have a definite tell-tale as to the balance of the rations, and as in all cases it is necessary for the birds to carry condition, it will be evident that the birds should always carry a small layer of fat. This is a reserve to meet any emergency such as cold snaps, etc. The feeding is therefore controlled to obtain the maximum results, whether it be for body, eggs or quick growth of feathers, and a correct amount of fats to meet the emergencies.

It has been previously mentioned that a fairly definite guide to the balance of the rations is the colour of the droppings under the perches. The colours of the droppings can vary from light yellow to dark brown, to black, then to a slight reddish tinge. Be careful you are not confusing the colours if you are using charcoal or the soil is of a reddish nature. We must compensate for this, as the birds will consume the charcoal and soil and that will pass through, causing a false colour.

If it is yellow we have too much carbohydrates and fats to protein—the ration is "too wide."

If it is brown this means the same—"too wide."

If it is black-brown we have a ration as near as desired.

If it is black we are near the danger zone.

If it is red bloodish colour the ration is "too narrow," and dangerous.

Aim for the black-brown colour—and satisfaction. Do not consider the white tips—these are urine and are of no importance to our discussion. Simply this—if light brown, too much wheat to meat; if black-brown, correct; if reddish, too much meat to wheat. Remedy by varying the meatmeal. It is the highly concentrated protein ingredient and it can influence the ration quickly.

When gauging colour, take a quick glance for colour effect, not an isolated concentration.

This sign will give you a base on which to work, but as one cannot define the close shades of black-brown, it is necessary to handle the bird for a check and note the condition. If the colour of the droppings is black-brown and the bird is putting on fat, it is evident that the colour is not of the correct shade. Furthermore, it is not possible to gauge the correct shade, so resort must be made to handling. If the fat layer is increasing, a small addition to the percentage of meatmeal will reduce the fat, but to all intents and purposes the colour change may not be evident. But that doesn't mean that there has been no change. You can therefore be sure that if the fat is too great you are to add more meatmeal and keep at the extra amount until a reduction is noticed. On the other hand, too high a percentage will be noticed by the reddish colour in the droppings and also in the poor, lean condition of the flesh. The flesh will appear to be of a jelly-like substance and not having that firm feel which is noticeable when the birds are in good condition and carrying a little fat.

It will be realised also that the percentages of protein must vary according to the season. In the winter the energy-forming foods which supply the source of heat will be assisting to keep the bird warm. They will have two works to perform—producing eggs or feathers and supplying warmth. The proteins, therefore, must be lower in proportion; whereas in the summer no energy-forming food is required for keeping the bird warm, and therefore the proteins must be in greater proportion than in winter. This is evident by the colour of the droppings.

If one standard ration is used throughout the year, it will be found that the birds will be thin in the winter and then place on fat in the summer. It is generally the fat birds which die in the heat waves. The practice, therefore, is to so fluctuate the rations so as to meet the seasonal conditions.

Further, as the proteins are used to make eggs, a change in the percentage of this ingredient is necessary during certain periods of the year. In the winter the birds will be requiring less protein for egg production than they will when the production rises to the peak in the spring, and as the reduction in the egg production takes place in the summer the protein used for egg production will be less.

When the autumn approaches the birds will be ceasing their production, as they will be preparing for the annual moult, and as winter is approaching they will require a reserve of fat to meet the cold blasts of the winter season The percentage of protein is therefore reduced because of the two factors reduction in the lay and the approach of winter. When the feathers are growing, the birds will need an addition of protein again. All these alterations are appearing complicated, but the signs are simple and definite. The condition of the bird is the real one and only guide, and by using more or less meatmeal in the rations, one will be able to alter the percentage of proteins from day to day if necessary. A little fat in the winter, none in the summer, and as the winter approaches again, a slight addition. When the birds are moulting you will be able to correct the

rations if you watch the condition of the bird. Any tendency to placing on thick layers of fat will tell you immediately that the bird is not receiving sufficient meatmeal from which to make the quick growth of feathers.

Fat Requirements.—When the pullets are beginning to lay, it will be noticed that there is very little fat between the pelvic bones and the breast bone, but as the winter approaches this layer should be about ⅝in. thick for the light breeds and about ⅞in. for the heavy breeds. When the spring approaches the birds are laying many more eggs and this layer must be reduced so that the thickness in the summer should be about ⅜in. for the light and about ½in. for the heavy breeds.

If for any reason the birds are not fed sufficient protein, it will be noticed that the fat grows thicker and this is the sign that the rations are not balanced. On the other hand, should the fat disappear or be less than the amounts suggested above, the manager should reduce the meatmeal immediately.

All fluctuations are done gradually. It would be dangerous to keep the meatmeal at a double quantity for any length of time, but double meatmeal for two or three days would not injure the birds if they were carrying fat. And again, the reduction of the meatmeal by half for any lengthy period would be quickly noticed by an immediate reduction of production.

Our Australorps are condemned as layers for more than one year, and all because the feeding is at fault. The birds have been allowed to get fat when in the moult. They must have a rest from laying, but if the meatmeal is withdrawn from the rations during this moulting period it will immediately show up. The bird will get fat and the time taken to grow the feathers will be prolonged.

The moulting bird must have meatmeal in order to produce a quick growth of feathers.

The wheat farmer and those who are feeding wheat have no problems which cannot be solved as easily as those arising when feeding bran and pollard.

Green Feeds.—It has been the practice to impress upon the farmer that greens of some sort are necessary to the well-being of the fowls. But in some districts it is well nigh impossible to procure green feed. In those districts it is necessary to resort to substitutes. And there are several.

Sprouted grains are the most popular means of supplying the greens, but other substitutes can be used. One can use chaff—either lucerne, wheaten or oaten.

Sprouted Grains.—Sprouted grain is one of the simplest means of obtaining the green feed requirements of the flock. The grain is soaked for 24 hours and then spread out either in troughs, on bags, or in trenches in the ground. Each day a further amount is soaked and spread and after seven days the resultant growth is used for feeding in the wet mash in the morning and after the wheat in the evening. The average growth after seven days is about four inches. This method will assist the feeding and at the same time will provide the requisite amount of necessary vitamins. The troughs are made with wood bottoms and have a side board. The grain, after soaking, is spread over the trough to a thickness of one inch. Every day the grain is sprinkled with water to keep a continued growth. To feed in the mash, cut off the young shoots and cut fine. For the evening feed the tender roots are cut into portions and eaten by the fowls with relish.

When using bags on which to spread the soaked grain it is advisable to cover with a top bag, keeping the top bag wet for two days, after which it must be removed. Daily watering is then necessary.

The most popular method of sprouting grain when water is a serious consideration is to place the soaked grain in a shallow trench in the soil in a shady portion of the farm. If necessary, build a bough shed for covering. A trench is made by using a shovel. Make the trench shovel width and about two inches deep. The length depends on the amount required for the daily feed. After soaking for 24 hours, the grain is spread in the trench to a depth of one inch and is then covered with a layer of soil about ¼ inch deep. There is sufficient moisture in the soaked grain to keep continual growth for the seven days or even longer.

When wanted for use, the shovel is run under the roots and the trench can then be used for a further supply.

In all cases the amounts necessary for the day's feeding can be easily ascertained.

The above three means of obtaining greens are within the reach of every farmer and therefore the birds will be all the better if fed the necessary daily amount.

Chaffed Hays.—If one prefers to use substitutes for green feeds, one can resort to the use of chaff. Lucerne chaff is one of the most popular feeds. The cost is small and all that is necessary is to soak the chaff overnight in hot water. Nevertheless, the farmer has his own supply and there should be no need for him to purchase lucerne chaff. When cutting the wheaten or oaten hay for his stock the supply is immediately available for the fowls.

But the hay must be cut green. Any tendency to dry yellow straw and a little grain in the heads is unsatisfactory. When cutting the hay, the grain should be soft and the whole of the plant should be in a green condition. When made into hay and chaffed the resultant feed is easily steamed when wanted and fulfills the objective of supplying the bulk of the vitamins. Chaffed hay, whether lucerne, oaten or wheaten, is an excellent substitute for green feed, but it is not as palatable as the succulent green feed. Nevertheless, for those who are without the means of obtaining greens the use of either one of these chaffs will meet all requirements.

The steamed chaff can be used in the wet mash in the morning, the dry chaff can be added to the dry mash, and the grain can be soaked for an evening feed. Or the chaff can be used in the mash, and for an evening meal the sprouted grain can be given after the hard grain.

With the feeds available, together with the means of obtaining green feed, or the substitute of soaked chaff, the farmer in the dry wheat areas will be well served with all the essential foods required. There is no reason why the egg production and condition of the flock should not be all that is desired.

If the principles of feeding are kept uppermost in the minds of the manager, it is easy for all the foods mentioned to be used in varying forms. It is also easy to so arrange the organisation of feeding to be a pleasure rather than a drudgery. The birds will want a well-balanced ration, a supply of green feed or its substitute, and the various minerals which assist to keep the birds in good health and high production.

The minerals are to be found in the feeds supplied. All that is then necessary is to augment the minerals with the shell grit for egg shell formation, the hard grit for assisting the bird to grind its food, and fine charcoal to keep the digestive organs in clean condition.

THE VALVE POTENTIOMETER AND ITS APPLICATION TO pH DETERMINATION.

By H. H. KRETCHMAR, B.Sc., A.A.C.I.

FOREWORD.

Those readers interested in valve potentiometers will know that a large amount of data has been published in this connection, but, as it is scattered throughout many journals, some not easily accessible, the writer has considered it advisable to collect together all such data as is relevant to the design and use of a potentiometer for pH determinations.

For the benefit of those chemists not acquainted with the theory of the modern valve, a short introductory section on this subject has also been included. The theory of the grid circuit has been reconsidered and the effect of the valve internal grid-filament impedance taken into account. Also a section has been added which enables one to calculate the optimum value of external valve anode resistances (an important factor in the design), which, it is believed, has not previously been considered.

INTRODUCTION.

The following very brief notes may serve as an introduction to the action of the valve.

The thermionic valve consists of an exhausted envelope, generally made of glass, containing a number of metal elements known as electrodes. One of these electrodes, the cathode, is a source of electrons. It may be directly heated by the passage of an electrical current—the filament current—or indirectly heated by a special heater element which is itself heated by an electrical current. The emissivity of the cathode may be, and generally is, in the modern valve, increased very greatly by coating it with thorium or with a layer of one of the alkaline earth oxides such as barium oxide. The indirectly heated cathode has advantages over the directly heated filament type. Such advantages are an equipotential surface and comparative freedom from heating current variations, so that alternating current may be used.

The simplest thermionic valve contains, as well as the cathode, a second electrode known as the anode or plate. If the anode be connected to the cathode through a milliammeter a positive current will be indicated flowing from the cathode to the anode in the external circuit. This is due to the electron stream flowing from the cathode to the anode within the valve. Since the current is due to a unidirectional electron flow, the device is a rectifier. All the electrons emitted by the cathode do not reach the anode and there is an accumulation of them in the inter-electrode space giving rise to the "space charge." If the anode is given a positive potential with respect to the cathode more electrons are attracted to the anode or plate and the anode or plate current increases. With increasing positive potential on the anode the anode current increases until all the electrons emitted by the cathode are being collected by the plate: further increase of anode potential causes no further increase of anode current for that particular cathode temperature and this maximum anode current is known as the "saturation current" for the particular filament temperature being used.

In the three-electrode valve a further electrode, known as the grid, is added. This usually takes the form of a mesh or coiled wire grid and is almost invariably placed between the cathode and the anode. When given a negative potential with respect to the cathode it acts as a partial barrier to the flow of electrons from the cathode to the anode, its effectiveness in this respect depending upon the magnitude of the negative potential applied to it.

If now the anode current for such a three-electrode valve be determined for various values of anode and grid voltage, the results may be plotted to give a graph of the following form (see Fig. 1). Each curve corresponds to a fixed anode voltage. Generally, the upper flat portion of the curves corresponding to the saturation current will not fall within the working range of a modern valve.

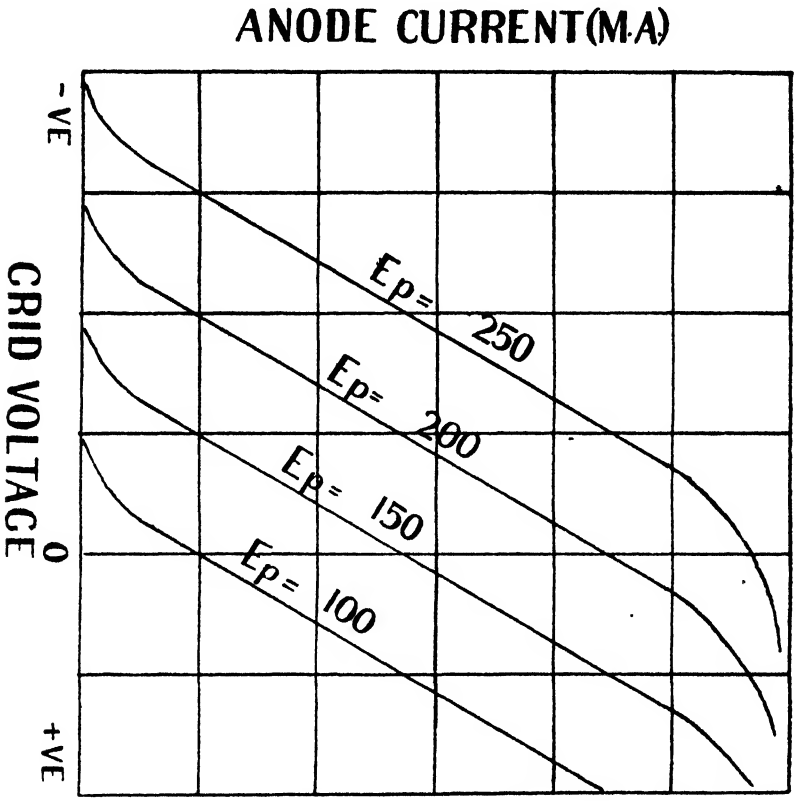


FIG. 1.

Expressed in its most general form the equation for the plate current is

$$i_p = E_p \frac{\delta i_p}{\delta E_p} + E_g \frac{\delta i_p}{\delta E_g} + i_o$$

Now for the greater part of their length the characteristics are straight lines and this leads to considerable simplification of the above equations. We can write

$$\frac{\delta i_p}{\delta E_p} = \frac{1}{Z_p}$$

where Z_p is called the valve impedance, and also

$$\frac{\delta i_p}{\delta E_g} \Big/ \frac{\delta i_p}{\delta E_p} = \mu$$

where μ is called the amplication factor of the valve. Over the straight region of the characteristics it is obvious that both Z and μ will be constants. i_o is

generally small. Introducing the new symbols, and neglecting i_o, the equation for plate current, to a first approximation, may be written

$$i_p = \frac{1}{Z_p}\left(E_p + \mu E_g \right)$$

The tetrode valve is a further development of the three-electrode valve and contains a second grid which may be used in either of two ways :—

Firstly, it may be placed close to the filament and used as a "space charge" grid. The reason in this case for its proximity to the filament is that in such a position it lies where the "space charge" is most dense. When given a positive potential it serves to neutralise to some extent the "space charge" which would otherwise limit the anode current. The screen grid also takes a current which may be used (*e.g.*, in the case of the American General Electric F.P. 54 Pliotron) to counterbalance random fluctuations in the anode current and so stabilise the circuit (v.i.).

Secondly, the extra grid may be used to screen the control grid against anode potential variations. The operation of the screen grid depends upon its being maintained at a fixed potential. If its potential does not fluctuate as a result of fluctuations of anode potential, then the control grid, which is screened by it, cannot receive energy from the anode and is, therefore, not influenced by it.

The screen grid tube is limited in its power-handling capacity. When the anode potential variations are so great as to bring its potential to a value near the potential of the screen grid, the anode current suddenly drops almost to zero. This is due to the fact that secondary emission effects are produced and the electrons from the plate are collected by the screen grid, thus affecting its potential. In order to overcome this secondary emission effect, a fifth electrode, known as the supressor grid, is inserted between the anode and the screen grid. The result is the modern pentode or five-electrode valve.

EARLY DEVELOPMENTS.

The value of the thermionic vacuum tube as a means of measuring potential difference has long been recognised (2), and the Moullin voltmeter (3) is now a commercial instrument. Goode (4) appears to have been the first worker to suggest the use of the valve in electrochemical problems. Fig. 2 shows the early circuit of Goode.

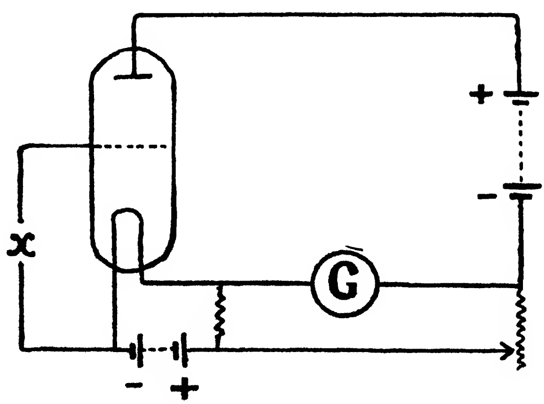


FIG. 2.

The E.M.F. to be measured is connected in the grid circuit of the valve at x and the current through the anode circuit read by means of the galvanometer G. By means of suitable shunts or preferably a suitable back E.M.F. in the anode circuit the scale of the galvanometer may be suitably adjusted and may be calibrated to read the E.M.F. of x directly in volts. Since the cell x undergoing measurement is in the grid circuit of the valve the current drawn from the cell is very small. However, there are several disadvantages in this original circuit:—

1. The sensitivity is not great.
2. The current drawn by the valve (which may be of the order of 10^{-6} amp.), although small, is appreciable and sufficiently large to make the instrument valueless for glass electrode work.
3. There is a zero drift.

The sensitivity may, of course, be increased by means of a valve amplifier, but since this simultaneously magnifies the zero drift, there is little or no improvement in accuracy.

SOME CONSIDERATIONS REGARDING THE CELL BEING TESTED AND THE GRID CIRCUIT.

Let us first consider the effect of cell resistance upon the time required for the grid of the valve to assume the E.M.F. of the cell being measured. In the original treatment of the problem, (1) the internal grid filament impedance of the valve was neglected. This is now taken into consideration. In the diagram, Fig. 3,

C_g represents the grid cathode capacity of the valve.

Z_g represents the internal grid cathode impedance of the valve.

E_x represents the E.M.F. due to electrode assembly, potentiometer, etc.

R_x represents the total resistance of the electrode assembly, etc.

For the calculation it is assumed that the valve is normally operated at "free grid potential," which should be the case when testing high resistance cells.

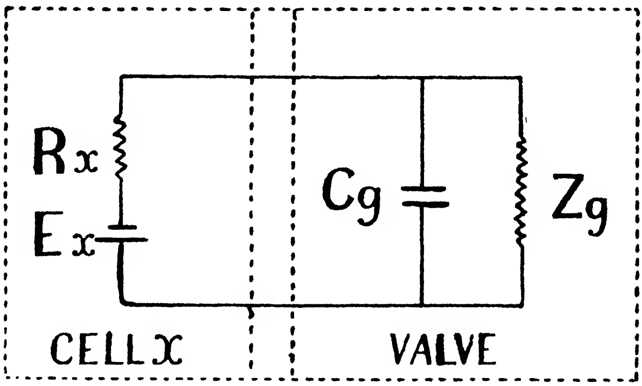


FIG. 3.

Consider the condition when the condenser has a charge Q.

$$\text{Voltage across the condenser} = \frac{Q}{C_g}$$

Rate of flow of current into condenser $= \left(E_x - \dfrac{Q}{C_g}\right) \Big/ R_x$

Rate of flow of current out of condenser $= \dfrac{Q}{C_g} \Big/ Z_g$

Therefore charging current $= \dfrac{dQ}{dt} = \dfrac{E_x - \dfrac{Q}{C_g}}{R_x} - \dfrac{\dfrac{Q}{C_g}}{Z_g}$

Integrating $\quad Q = \dfrac{Z_g}{Z_g + R_x} \cdot E_x C_g \left(1 - e^{-\frac{R_x + Z_g}{Z_g} \cdot \frac{t}{C_g R_x}}\right)$

The ratio of the voltage E', built up across the grid filament circuit to the applied voltage E_x (after a lapse of time t secs.) will be

$$\frac{E'}{E_x} = \frac{Z_g}{Z_g + R_x}\left(1 - e^{-\frac{Z_g + R_x}{Z_g} \cdot \frac{t}{C_g R_x}}\right)$$

Obviously, R_x and Z_g form a potentiometer system which governs that fraction of the voltage E_x which will eventually build up across the condenser. Thus, the final potential which will be built up across the condenser is

$$E'' = E_x \cdot \frac{Z_g}{Z_g + R_x}$$

If we have a glass electrode system with a resistance about $10^8\omega$ and the impedance of the valve is only $10^8\omega$, only 50% of the applied voltage builds up across the valve grid circuit. If Z_g is as high as $10^{10}\omega$, approximately 99% of the applied voltage will become effective across the valve grid circuit. To increase the valve impedance has little further value in this respect.

With a low resistance electrode system, resistance of the order of $10^3\omega$, it is obvious that a valve having a grid resistance as low as $10^5\omega$ will be satisfactory.

Having now arrived at a suitable ratio between the resistance of the electrode assembly and the internal impedance of the valve grid filament circuit, the time constant of the circuit may be considered.

If the ratio of Z_g/R_x be kept to at least 100, the factor $Z_g/(Z_g + R_x)$ is approximately equal to one, and may be neglected when considering the time factor in the grid circuit.

Introducing this simplification

$$\frac{E'}{E_x} = 1 - e^{-\frac{t}{C_g R_x}}$$

which is the same equation as originally published (1).

Considering the case of a glass electrode system having an internal resistance of $10^8\omega$ (about the usual value for modern instruments) and a valve having a grid filament capacity of $3\mu\mu F$ (an average value for small valves such as would be used) and a grid filament impedance of $10^{10}\omega$, it may be calculated that almost the whole of the applied voltage is effective across the valve at the end of one second.

Had the cell resistance been $10^{12}\omega$, it would have been advisable to employ a valve having a grid filament impedance of the order of $10^{14}\omega$. The time constant of the circuit with these values for the components would then become appreciable. At the end of 10 seconds it may be calculated that 96% of the applied voltage is effective across the valve grid circuit.

In order that the full voltage of the cell shall be applied to the grid within a reasonable time, it is necessary that Z_g/R_x shall be large and C_gR_x small. These conditions are naturally more difficult to attain when the electrode resistance (*i.e.*, R_x) is large.

If R_x is $10^8\omega$ and Z_g is $10^{10}\omega$, and the departure from the exact "free grid" potential point is 0·1 M.V., the grid current will be

$$\frac{10^{-4}}{10^8 + 10^{10}} \doteqdot 10^{-14} \text{ amp.}$$

The deviation of the voltage measured, from the voltage of the cell X on open circuit, due to the voltage drop caused by the flow of grid current, will be

$$R_x i_g = 10^8 \times 10^{-14} = 10^{-6} \text{ volt}$$

For comparison it may be mentioned here that the grid current of the special electrometer valves is between about 10^{-13} and 10^{-15} amp. at working potentials (v.i.). They are not operated at "free grid" potential.

The amount of chemical change caused by the flow of grid current may next be considered. One electrochemical equivalent of any substance requires 96,500 coulombs for complete change. Suppose a 0·001 N solution is being investigated, the quantity contained in the electrode vessel being 1 ml. The quantity of substance in this volume of fluid is 10^{-6} equivalent, so that the number of coulombs required to cause complete chemical change is

$$96{,}500 \times 10^{-6} \doteqdot 10^{-1} \text{ coulomb}$$

Now suppose the measurement is completed in one minute, and the current drawn by the grid circuit is 10^{-14} amp., the number of coulombs of electricity passed through the cell in this time is

$$10^{-14} \times 60 = 6 \times 10^{-13} \text{ coulomb}$$

Therefore, the percentage chemical change is

$$\frac{6 \times 10^{-13} \times 10^2}{10^{-1}} = 6 \times 10^{-10} \%$$

From the above reasoning it can be said that, in practice, we are limited to cells having a resistance of about 10^{12} ohms; with average glass electrodes the

current drawn from the cell with quite ordinary valves will be of the order of 10^{-14} amp.; and further that the amount of electrochemical change will be negligible.

Let us next consider the grid characteristics of a valve. Fig. 4.

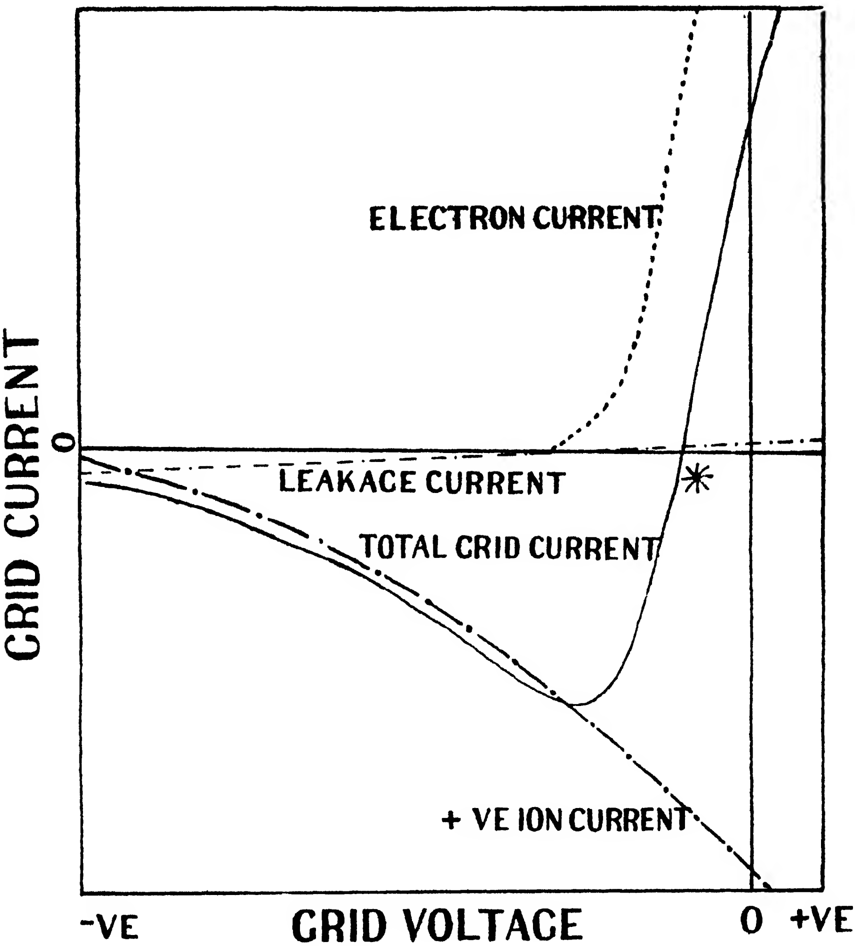


FIG. 4.

It will be noted that the total grid current chiefly comprises three separate currents :—

1. The leakage current from the valve grid to the various other elements.
2. The electron current.
3. The positive ion current.

It should be specially noted that at the point marked * the sum of these currents is zero, so that if the valve is operated at this point no current will be drawn from the external grid circuit. The potential necessary to bring the grid to the point marked * is known as the "free-grid potential." It is the potential assumed by the grid when left on open circuit.

ELECTROMETER VALVES.

Special valves, electrometer tubes, have been designed (15) having a very low grid current. This condition has been arrived at by the following means :—

(a) By supporting the grid assembly on long quartz insulating pillars and taking the grid connection to the top of the tube. This reduces inter-electrode surface leakage.

(b) By using a well thoriated tungsten filament which can be operated at very low temperatures and still produce adequate electron emission. This cuts down thermionic emission and photo-electric emission from the grid (due to light from the filament) and minimises some of the effects in (c).

(c) By using very low anode voltages. This reduces electron emission from the grid due to X-rays produced at the plate by high speed electrons. The voltage is kept low enough to cause little or no ionisation of the residual gas in the tube.

(d) By providing the valves with a screen grid which screens off positive ions (emitted by the filament) from the working grid. Further, the grid may be placed external to the electron current.

The following table gives the characteristics of a number of valves of this class :—

Tube.	E_p	E_{sg}	E_g	E_f	i_f	i_g	$G_m, \left(\frac{\mu A}{V}\right)$
Gen. Elect. F.P. 54	6	4	-4	2·5	110	$\sim 10^{-15}$	$\sim$ 25
A.E.G. T113	7	5	—3	3	100	$\sim 10^{-13}$	$\sim$ 80
A.E.G. T114	6	4	—3	2	80	$\sim 10^{-14}$	$\sim$ 30
L. St. R. II. Straub .	6	4	—4	2·5	130	$\sim 10^{-14}$	$\sim$ 50
Phillips 4060	4		-3	·56	1100	10^{-14} to 10^{-15}	$\sim$ 30
Western Elect. D96475	4	4	—3	1	270	$\sim 10^{-15}$	$\sim$ 40
Mazda UX54	6	4	—4	2·5	100	$\sim 10^{-15}$	$\sim$ 25

The low grid current, however, is obtained at the expense of power handling capacity, amplification factor and mutual conductance. These factors, combined with the fact that the valves should be operated in a rather unstable manner, as will be described later, appear to make them much less desirable from our point of view than the more ordinary radio valves.

THE SINGLE VALVE CIRCUIT.

Penick, in his paper (5), reviews the circuits of Compton & Haring (27), Soller (24), Du Bridge & Brown (23), Harnwell & Van Voorhis (25) and Barth (26), and suggests the following slightly modified Barth circuit as being the best. Fig. 5.

It will be noted that the circuit is a modified Wheatstone Bridge in which the resistance of one of the bridge arms is replaced by the anode filament resistance of the valve. The filament heating current, grid bias voltage, screen grid current and anode current are supplied by the same battery so that by choosing suitable values for the various resistances, it is possible to arrange for the correct grid bias value, anode voltage, filament current, etc., and at the same time arrange

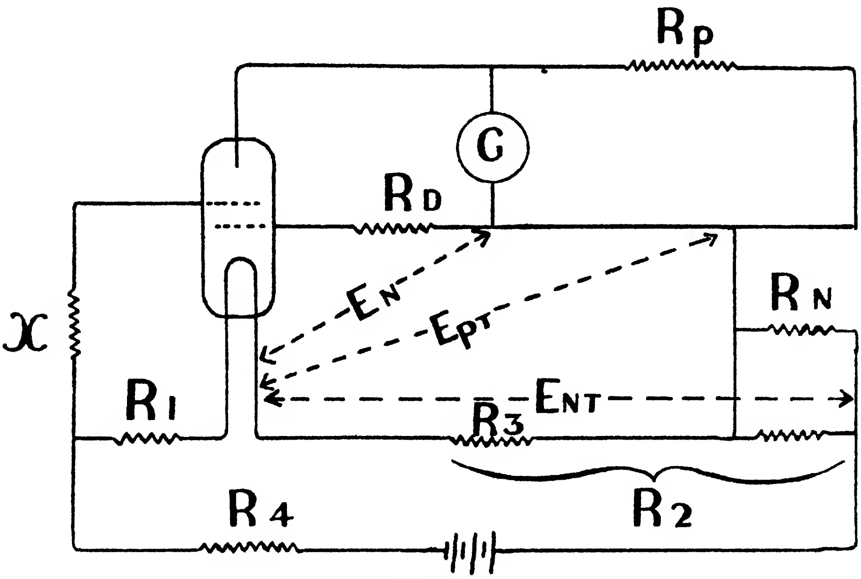


FIG. 5.

that disturbances produced by changes of battery voltage in any one part of the circuit are compensated by changes simultaneously produced in other parts of the circuit. Briefly stated, it is necessary to arrange that—

1. The correct voltages shall be applied to the various electrodes of the valve.
2. The galvanometer current shall tend to zero.
3. The galvanometer current shall be constant for small variations of battery voltage.

The expressions for calculating the values of the resistances required may be derived from the following circuit equations:—

$$i_f R_1 = -E_g \qquad (1)$$

$$i_f R_2 + E_f = E_n + i_n R_n = E_{nt} \qquad (2)$$

$$i_f R_3 + E_f = E_p + i_p R_p = E_{pt} \qquad (3)$$

$$\frac{1 + R_p\left(\dfrac{\delta i_p}{\delta E_p} + \dfrac{\delta i_p}{\delta E_n}\right)}{1 + R_n\left(\dfrac{\delta i_n}{\delta E_n} + \dfrac{\delta i_n}{\delta E_p}\right)} = \frac{\dfrac{\delta E_f}{\delta i_f} + R_3 - R_p\dfrac{\delta i_p}{\delta i_f} + R_1 R_p\dfrac{\delta i_p}{\delta E_g}}{\dfrac{\delta E_f}{\delta i_f} + R_2 - R_n\dfrac{\delta i_n}{\delta i_f} + R_1 R_n\dfrac{\delta i_n}{\delta E_g}} \qquad (4)$$

Since there are only four equations to be satisfied and the circuit includes 5 variables, the system is flexible. It is thus possible to fix e.g. battery voltage and adjust the resistances to suit. Supposing this voltage to be fixed R_2 may be set at such a value that the required voltage-drop is produced by the normal filament current across the series combination R_2, R_1 and R_f. The value of R_n is then fixed by equation (2) and R_1 by equation (1). R_3 and R_p are left to be fixed from equations (3) and (4). Solving these equations—

$$R_p = \frac{R_n \left\{ \left(\frac{\delta i_n}{\delta E_n} + \frac{\delta i_n}{\delta E_p} \right) \left(E_p + i_f \frac{\delta E_f}{\delta i_f} - E_f \right) - \left(i_n - i_f \frac{\delta i_n}{\delta i_f} + i_f R_1 \frac{\delta i_n}{\delta E_g} \right) \right\}}{\left(\frac{\delta i_p}{\delta E_p} + \frac{\delta i_p}{\delta E_n} \right) \left\{ \left(E_p + i_f \frac{\delta E_f}{\delta i_f} - E_f \right) + R_n \left(i_n - i_f \frac{\delta i_n}{\delta i_f} + i_f R_1 \frac{\delta i_n}{\delta E_g} \right) \right\} - \left\{ 1 + R_n \left(\frac{\delta i_n}{\delta E_n} + \frac{\delta i_n}{\delta E_p} \right) \right\} \left(i_p - i_f \frac{\delta i_p}{\delta i_f} + i_f R_1 \frac{\delta i_p}{\delta E_g} \right)} \qquad (5)$$

$$R_3 = \frac{1}{i_f} \left(E_p + i_p R_p \right) \qquad (6)$$

The stability of the single valve bridge circuit against random battery fluctuations depends upon the condition that the valve operates as a purely ohmic resistance. This is accomplished by running the valve with low filament current so that it is possible to work on the curve of the plate current-plate volts characteristic which occurs towards the saturation current section of the characteristic. A point is selected on this curved part of the characteristic such that the tangent to the curve through the operating point passes through the zero current-zero voltage point. The necessary point is represented by the point * in Fig. 6. Obviously, any change in the operating point, say by valve aging, causes a departure from the necessary condition referred to above.

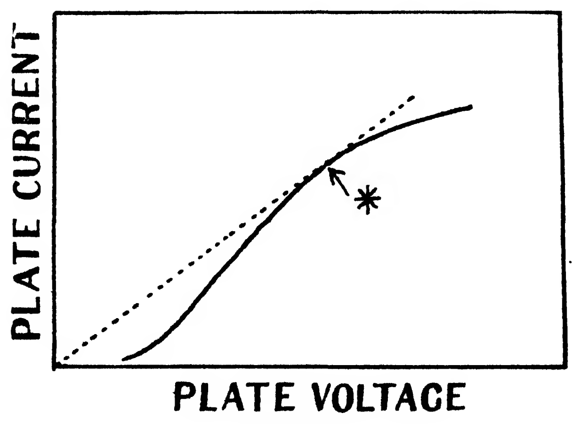


FIG. 6.

THE TWO-VALVE BRIDGE CIRCUIT.

This circuit appears to have been suggested first by Wold (6) and Brentano (7) and developed by Schwarzenbach (8), Stadie (9), Razek & Mulder (10), Stadie, O'Brien & Laug (11), Garman & Droz (12). The two-valve bridge circuit is easier to set up than the single-valve circuits, and has the advantage of greater stability because the valves are operated at a more rational point on the characteristic, *i.e.*, where the characteristic is approximately straight. There is zero galvanometer current for no applied grid voltage. Compensation for anode and filament battery changes may be arranged, and with fairly well matched valves there is approximate compensation for aging of the tubes. This latter feature cannot be arranged for single-tube circuits. Fig. 7 will serve to show the fundamental principles of the two-valve bridge circuit.

If the valves were perfectly matched and $R_1 = R_2$ it would only be necessary to make the tapping point on R_1 the same as the tapping point on R_2, place the anode voltage tap at the mid-point of R_3, place the filament voltage tap at the mid-point of R_4, adjust the grid bias on each valve to the same value by means of the potentiometers P_1 and P_2 to balance the bridge. Unfortunately it is almost certain that the valves will not be exactly the same and it thus becomes necessary to so balance the bridge that compensation is effected for changes of filament and battery voltage and for differences of valve impedance.

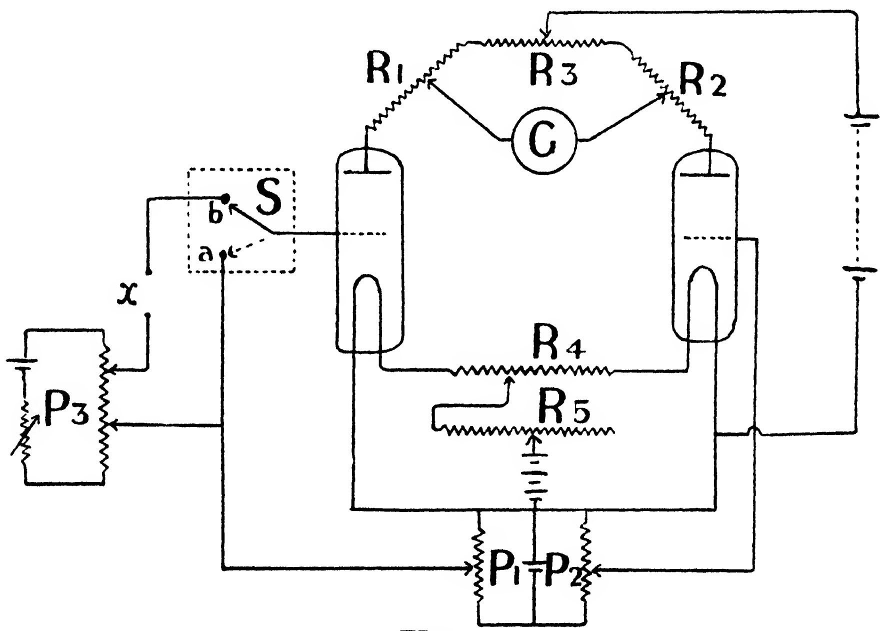


FIG. 7.

This balancing is performed by trial and error, as follows:—The slider is set at the midpoint of R_3 and the sliders set to corresponding points on R_1 and R_2. The slider is set to the mid-point of R_4. The potentiometers P_1 and P_2 are next adjusted, and if the valves are well matched balance will occur when the bias due

to P_1 is nearly the same as the bias due to P_2. Generally, due to differences in the emission from the two valve filaments, balance is upset when the filament current changes, as may be ascertained by varying the contact on R_5. To compensate for this difference of emissivity of the valve filaments the contacts on R_4, P_1 and P_2 are altered until no deflection of the galvanometer occurs when the slider on R_5 is altered. To compensate the bridge for fluctuations of anode battery potential the contacts on R_1, R_2 and R_3 are set so that no galvanometer deflection occurs when the anode voltage is altered. This last adjustment will have slightly upset the filament battery compensation, which must then be reset, and so on.

OTHER METHODS OF STABILISING THE BRIDGE.

A very neat method suggested by Turner (13) for compensating for changes of anode potential is the "μ balance" circuit. This method may be explained as follows:—

The rate at which the anode current of a valve varies with anode voltage, for constant grid voltage and filament current, is very constant for a good valve (with the exception of special types) over the operating range, *i.e.*, the anode current-anode voltage characteristic is straight over the operating range.

$$\therefore \quad \frac{\delta i_p}{\delta E_p} = \text{const.} = \frac{1}{Z_p}$$

Similarly, over the operating range, the rate at which the anode current varies with the grid voltage, the anode voltage being constant and filament current constant, is also very constant, *i.e.*, the anode current-grid voltage characteristic is straight over the operating range.

$$\therefore \quad \frac{\delta i_p}{\delta E_g} = \text{const.}$$

The ratio of the above constants is known as the amplification factor of the valve and is generally denoted by μ, thus—

$$\mu = \frac{\delta i_p}{\delta E_g} \Big/ \frac{\delta i_p}{\delta E_p}$$

This ratio expresses the relative effects of grid voltage to anode voltage on plate current.

The value of μ, the amplification factor, of any tube depends mainly upon the mechanical construction of the tube and only secondarily, and to a minor extent, upon such factors as current.

Now suppose that a potential divider is placed across the current supply to the valve anode filament circuit and from this potential divider is taken off a negative potential equal in value to the anode potential divided by the amplification factor of the valve, and this potential is applied to the grid of the valve. If an increase or decrease takes place in the supply potential tending to cause an increase or decrease in anode current, an exactly countering effect is produced by the change of the grid bias voltage, for an increase of potential produces an increase of negative bias and *vice versa*. The input impedance of such a device is infinite in value. The circuit of Fig. 8 shows the essentials of the scheme.

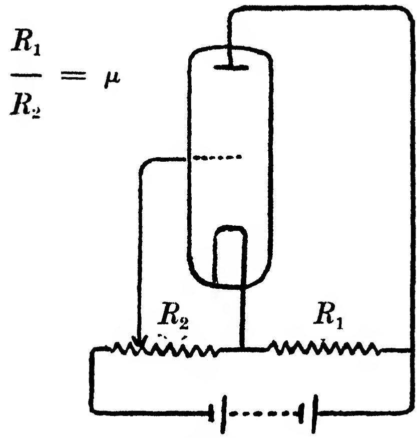


FIG. 8.

However, in general, it will be found impossible to work with the value of the grid bias produced by this scheme unless—

(*a*) the valve has a very high amplification factor ; or

(*b*) it is convenient to bring the grid to the desired operating point by means of a source of constant E.M.F. such as a Weston Cell (12).

This scheme will be particularly difficult to apply when it is desired to work at "free grid potential" because standard cells cannot be shunted by a potentiometer which draws current from the cell.

The relative stability of the μ-balance circuit to other single-valve circuits has been determined by Turner (13). The graphs of Fig. 9 are copied from Turner's paper. The curves show, in relative order of stability, the characteristics of a valve balanced against a resistance, operated as a "pure resistance," and stabilised by the μ-balance method.

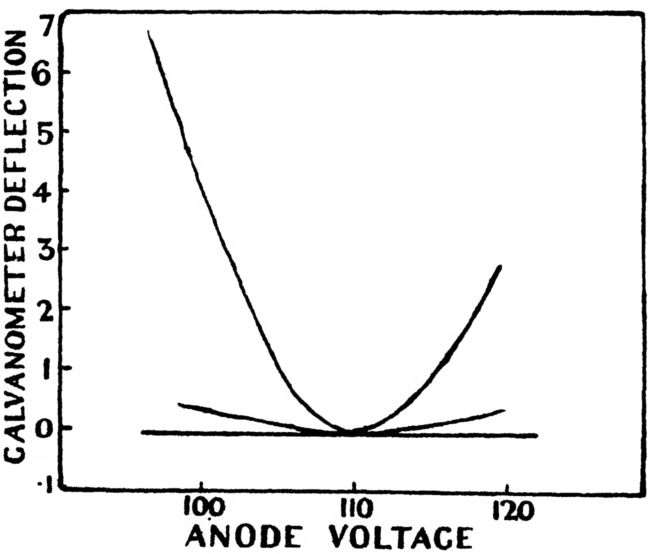


FIG. 9.

Various voltage and current stabilising devices are now obtainable at moderate cost, but no reference has be n noted of their use for the type of instrument we are considering.

The first device which seems worthy of attention is the barretter. This consists of a resistance and associated heater generally placed in an evacuated glass vessel to ensure stability. The values of the elements are so arranged that the increased temperature of the heater due to a rise of supply voltage causes sufficient increase in the value of the resistance to produce an increase of voltage drop across the resistance equal to the increase of supply voltage and *vice versa*. The current through the device thus remains substantially constant.

A similar constant current device is obtained by working an iron wire in an atmosphere of hydrogen. It would appear that these devices could well be used to stabilise the filament current of a valve bridge. Fig. 10 shows the characteristics of one of these barretters.

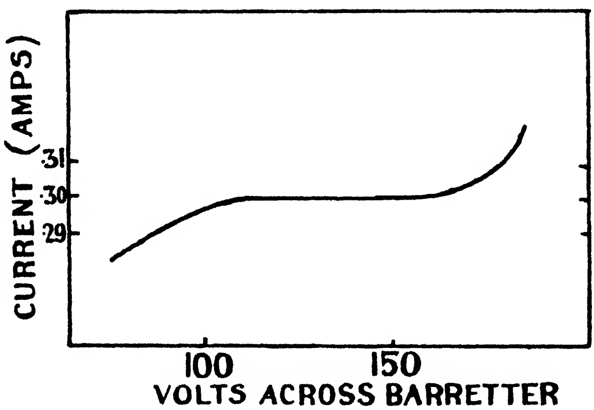


FIG. 10.

Another recently developed device which deserves attention is the glow discharge potential divider and voltage stabiliser (14). The instrument is marketed under the name of the "Stabilovolt Glowgap Divider." Several alternative voltages are available and it is stated that the output voltage does not vary more than $\pm 0 \cdot 2\%$ when the supply of voltage varies $\pm 10\%$ and that it falls about 1–2% as the load is increased from zero to full load. The various voltages are dependent on one another only to the extent of ·01–·02%. The instrument consists of a number of glow discharge gaps in series across the supply voltage. The gaps are mounted in a glass tube which contains gas (neon) at a pressure of a few cms. of mercury. The electrodes are of iron which is coated with some special material. Each intermediate electrode serves as the cathode of one gap and the anode of the next. Once the striking voltage has been reached the current which flows is mainly due to ionisation of the gas molecules by collision with the accelerating electrons, and this current, being thus a cumulative effect, is very sensitive to small changes in the accelerating voltage. The graph, Fig. 11, shows the type of characteristic.

On the applied voltage reaching the value A current commences to flow and the applied voltage falls to B. If there is no limiting resistance in the circuit (a resistance sufficient to cause a drop of 50% of the working voltage of the tube is required) a destructively large current will flow through the tube.

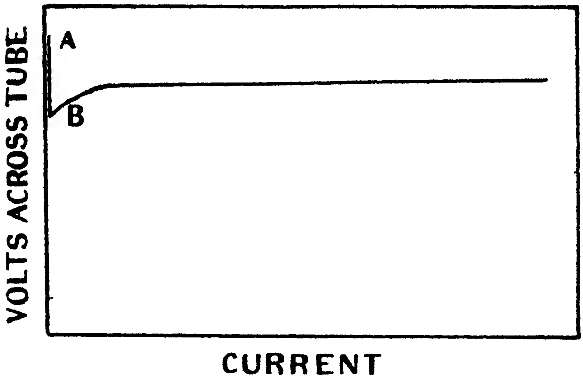
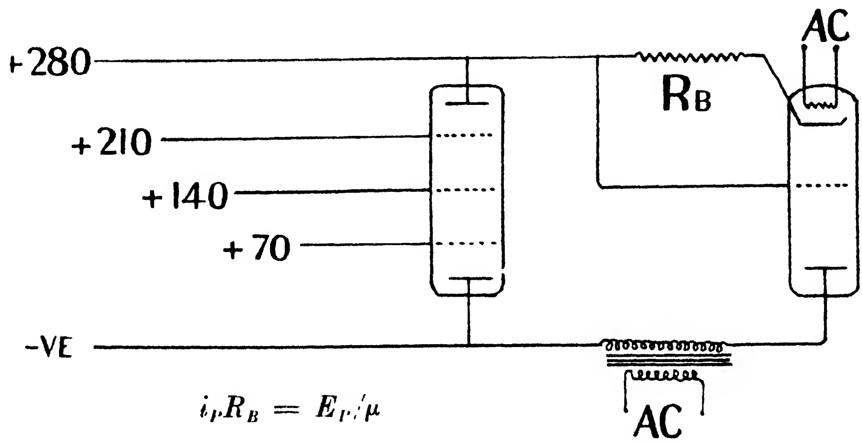


FIG. 11.

The "stabilovolt" functions as a battery of very low internal resistance to the instrument which it supplies with current. Low battery resistance is one of the desiderata for bridge sensitivity as may readily be proved by considering the effect of battery resistance when deriving the current equation for the bridge. It will be found that a further number of terms including battery resistance as a factor, are introduced into the denominator of the equation.

A three-element vacuum tube of the power type supplied with a suitable grid bias would appear to be a most suitable arrangement to use as a source of constant current supply for the glow-gap divider. The grid bias, equal to E_P/μ, should be obtained by a resistance of suitable value in the output circuit. No ballasting resistance would then be required and very little waste of power would result. This scheme is shown in Fig. 12, R_B representing the biasing resistance.



$$i_p R_B = E_p/\mu$$

FIG. 12.

It might be thought that an even neater arrangement would be to use a power amplifying valve as the rectifying valve for the bridge supply circuit with the μ-balance circuit arrangement applied to it to obtain a source of constant current. Such an arrangement, however, is not good, for it behaves as a battery of high internal resistance.

OPTIMUM VALUE OF RESISTANCES IN BRIDGE ARMS.

As will be shown graphically later, the sensitivity of the valve bridge potentiometer is greatly influenced by the value of the two valve anode resistances, but past workers do not appear to have derived the expression necessary to obtain the optimum value for them. The expression may be derived as follows:—

Consider the circuit shown in Fig. 13.

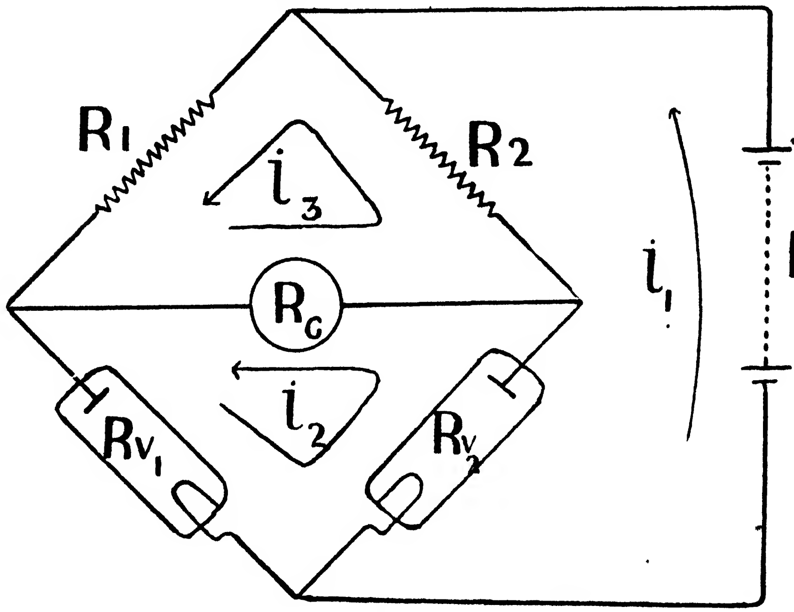


FIG. 13.

From Kirchoff's Laws.

$$E - R_{v_2}(i_1 - i_2) - R_1(i_1 - i_3) = 0$$

$$R_{v_2}(i_2 - i_1) + R_{v_1}i_2 + R_G(i_2 - i_3) = 0$$

$$R_1(i_3 - i_1) + R_1 i_3 + R_G(i_3 - i_2) = 0$$

From these equations it may be shown, by the use of determinants, that—

$$i_2 - i_3 = \frac{E\left(R_1R_{v_2} - R_1R_{v_1}\right)}{R_{v_1}\left(2R_1R_{v_2} + R_{v_2}R_G + R_1R_G + R_1^2\right) + R_1R_{v_2}R_G + R_1^2R_{v_2} + R_1^2R_G}$$

equn. (1).

This expression enables one to calculate the galvanometer current given the supply voltage and the resistance of the various elements of the bridge. The internal resistance of the source of current is assumed to be negligibly small compared with the other resistances: this is true with such devices as the glow-gap potential divider. It should be noted that the resistances R_{v_1} and R_{v_2} are neither true resistances nor valve impedances and may only be called the "effective valve D.C. resistances" for the particular conditions in which the valves are operating. These values should be obtained by dividing the applied potential by the actual current flowing.

The following table shows the galvanometer current (in M.A.) calculated by equation (1) for various values of anode resistance and galvanometer resistance. The values taken for R_{v_1} and R_{v_2} are 70,000ω and 25,000ω respectively which correspond approximately to an anode voltage of 200 volts and grid voltages of —2 volts and —1 volt for a certain valve.

$R_1 = R_2$.	$R_G =$				
	1000.	500.	100.	10.	1.
2	.	..	....	.	2·05
5			0·24		2·34
10	.		0·43	1·71	2·44
20		.	0·73	2·06	2·50
30		..	0·96	...	...
50	0·23	0·43	1·28	2·34	2·54
100	0·42	0·73	1·70	2·44	2·55
200	0·73	1·13	2·04	2·49	...
500	1·26	1·68	2·30	2·51	2·53
1000	1·65	1·99	2·38	2·49	2·51
2000	1·93	2·15	2·38	2·43	2·44
3000	2·01	2·18	2·33	2·37	...
4000	2·03	..	.	.	.
5000	2·03	2·14	2·24	2·26	.
6000				2·21	..
7000	2·00	2·07	2·14	2·15	.
10000	1·90	1·96	2·01	..	....

This data is depicted graphically in Fig. 14. The curves show that the galvanometer current increases very rapidly with the increase of anode resistance up to the optimum value, after which it slowly decreases. Consequently the anode resistances are better kept slightly higher, rather than lower, in value than the optimum.

By differentiation of equation (1) with respect to R_1, it may be shown that maximum galvanometer current is obtained when

$$R_1 = \sqrt{\frac{R_{r_1}R_{r_2}R_G}{R_{r_1} + R_{v_2} + R_G}} \qquad \text{equn. (2).}$$

The above formula (2) may be applied to the problem of valve bridge design as follows :—

An examination must first be made of the i_p-E_p characteristics of the valve it is proposed to use, and the position of the working point corresponding to the "balanced bridge condition" decided. If it is proposed to use the instrument as a null-point indicator for glass electrode work, the "free grid" characteristic must be shown. In the case of the "null-point" instrument a point is selected on the free grid curve not higher than the point of maximum plate current permissible. The plate current corresponding to the selected plate voltage is noted on the graph and the effective D.C. resistance calculated. In the case of the direct reading instrument, it is necessary to choose the point on the characteristic corresponding to the maximum negative grid bias which will be applied, for the valve will then have its maximum "effective D.C. resistance," which is the resistance value which should be chosen for calculating the optimum value for R_1. The

cell being measured should in practice be connected to the instrument to make the grid potential more positive in value. A sufficiently high plate voltage, not greater, however, than will produce the maximum permissible anode dissipation, should have been chosen for the characteristic to give adequate length of working line. The working point having been decided, the "effective D.C. resistance"

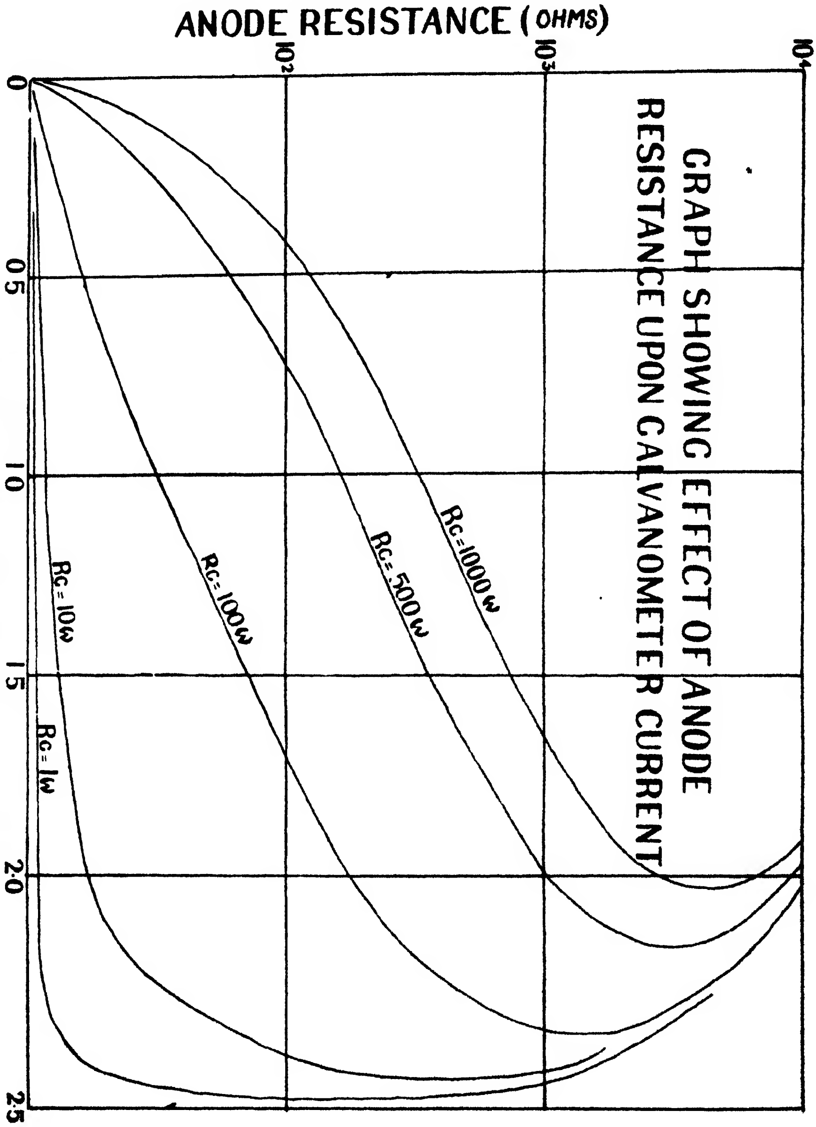


FIG. 14

at this point is calculated from the i_p and E_p values to which it corresponds. At the balanced condition R_{v_1} equals R_{v_2}. We also know the galvanometer resistance. Hence by equation (2) we may calculate the value of R_1. Having found the value of R_1, the voltage drop due to the flow of the plate current through it may be calculated, and this voltage drop together with the voltage across the valve gives the voltage which must be applied to the bridge.

SENSITIVITY OF THE TWO-VALVE BRIDGE CIRCUIT.

This problem has been adequately considered by Nottingham (16), who derived the following equation for the sensitivity of the circuit :—

$$\frac{\delta i_G}{\delta E_g} = \frac{G_m}{2 + R_G\left(\frac{1}{Z_{r_1}} + \frac{1}{R_1}\right)} \qquad \text{Equn. (3).}$$

In this equation G_m represents the mutual conductance of the valve, *i.e.*, the change in anode current caused by unit change of grid voltage.

The galvanometer is critically damped when

$$\frac{1}{R_{cd}} = \frac{1}{2Z_{r_1}} + \frac{1}{2R_1} + \frac{1}{R_d}$$

(where R_{cd} is the critical damping resistance and R_d is the shunt resistance), so that for critical damping of the galvanometer we have—

$$\frac{\delta i_G}{\delta E_g} = \frac{G_m}{2\left(1 + \frac{R_G}{R_{cd}}\right)} \qquad \text{Equn. (4).}$$

CONDITIONS FOR ZERO GALVANOMETER CURRENT OR BALANCE AND INDEPENDENCE OF BATTERY POTENTIALS.

The two-valve bridge is merely a special case of the ordinary Wheatstone Bridge arrangement, so it is obvious that the relation

$$R_1 R_{r_2} = R_2 R_{r_1} \qquad \text{Equn. (5).}$$

(where R_{r_1} and R_{r_2} are the "effective D.C. resistances") must hold for zero galvanometer current.

The current through the valves is expressed most simply by the equations—

$$i_1 = \frac{1}{Z_{r_1}}\left(E_p - \mu E_g - E'\right)_{r_1}$$

$$i_2 = \frac{1}{Z_{r_2}}\left(E_p + \mu E_g + E'\right)_{r_2}$$

Hence, for independence of anode potential changes, the following condition must hold :—

$$Z_1 R_1 = Z_2 R_2 \qquad \text{Equn. (6).}$$

Since Z_1 and Z_2 are constants depending on the valves, we must make

$$\frac{R_1}{R_2} = \frac{Z_2}{Z_1} \qquad \text{Equn. (7).}$$

and then obtain the relationship expressed by equation (5) by altering the grid potential of the balancing valve.

To obtain the conditions which are necessary for independence of filament battery changes, let us consider the equations for the valve currents.

If the filament voltage had been included as one of the variables in the current equations they would have been modified as follows :—

$$i_1 = \frac{1}{Z_{v_1}}\left(E_p + \mu E_g + E'\right)_{v_1} + \left(\phi E_f\right)_{v_1}$$

where $\phi_{v_1} = \left(\frac{\partial i_p}{\partial E_f}\right)_{v_1}$, $(E_f)_{v_1}$ = filament voltage of v_1 etc.

This shows that if the system is to be independent of filament voltage the further relation

$$\frac{\phi_{v_2}}{\phi_{v_1}} = \frac{R_1}{R_2}$$

must hold.

In practice, to compensate, the filaments are run in parallel with a variable resistance in series with one of them.

POTENTIAL MEASUREMENTS AT "FREE-GRID POTENTIAL."

Nottingham (16) has carefully analysed the circuit when operated in this condition. Consider circuit, Fig. 15.

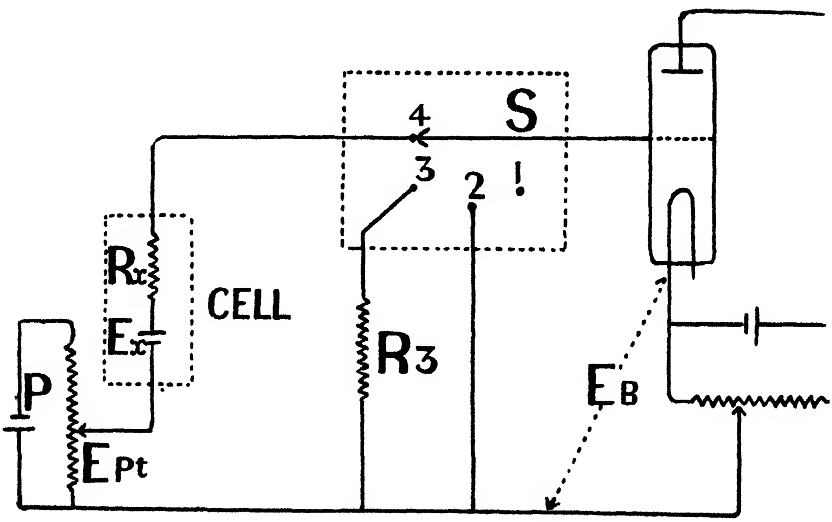


FIG. 15.

Assuming the resistance of the potentiometer P is small compared with the resistance of the cell being examined, we have from Kirchoff's Law

$$E_x + E_{Pt} + E_B = E_g + R_x i_g \qquad \text{Equn. (1).}$$

In order to read the value of the unknown potential E_x directly on the potentiometer we require

$$E_x = -E_{Pt} \qquad \text{Equn. (2).}$$

and this will be true when

$$R_x i_g = O \qquad \text{Equn. (3).}$$

for then

$$E_B = E_g \qquad \text{Equn. (4).}$$

Equation (3) does not have to be absolutely satisfied, and in practice what will be required is that

$$R_x i_g \text{ is small compared with } E_x\text{-}E_{Pt} = \delta E$$

where δE is the accuracy required in the measurement of E_x, say about 1 M.V.

The instrument is operated as follows:—

With the switch S in position 1 the bridge is balanced. The switch S is then changed to position 2 and E_B adjusted until the galvanometer again reads zero. There should be no galvanometer deflection now when the switch is moved from position 2 to 1, or *vice versa*. E_B is thus adjusted to free grid potential. As this test is more severe than is really necessary, one may proceed as follows:—The value of R_3 is made as large as R_x, and then the adjustment made as above using the switch in positions 2 and 3. To measure the potential of the cell being examined, the switch S is moved to position 4 and E_{Pt} adjusted to give zero galvanometer deflection. It should now be possible to move the switch S to either of positions 2, 3 or 4 without galvanometer deflection. The potential E_P now equals the potential E_x.

In order to find the rate of change of E_g with E_x we may refer back to an earlier section of the paper, where it was shown that a change, δE_x, of the potentiometer or cell produced a change, δE_g, on the grid, which were related as follows:—

$$\delta E_g = \delta E_x \frac{Z_g}{Z_g + R_x}$$

Then

$$\frac{\delta E_g}{\delta E_x} = \frac{Z_g}{Z_g + R_x}$$

Proceeding to the limit

$$\frac{\partial E_g}{\partial E_x} = \frac{Z_g}{Z_g + R_x} = \frac{1}{1 + \dfrac{R_x}{Z_g}}$$

This equation may be combined with the equation for sensitivity of the bridge to grid potential, *i.e.*,

$$\frac{\delta i_G}{\delta E_g} = \frac{G_m}{2\left(1 + \dfrac{R_G}{R_{cd}}\right)}$$

to give

$$\frac{\delta i_G}{\delta E_g} \times \frac{\delta E_g}{\delta E_x} = \frac{G_m}{2\left(1 + \dfrac{R_G}{R_{cd}}\right)} \times \frac{1}{1 + \dfrac{R_x}{Z_g}}$$

Further, defining the galvanometer response to current by

$$C_s = \frac{\delta \theta}{\delta i_G}$$

and including this in the above equation, we obtain

$$\frac{\delta i_G}{\delta E_g} \times \frac{\delta E_g}{\delta E_x} \times \frac{\delta \theta}{\delta i_G} = \frac{G_m}{2\left(1 + \dfrac{R_G}{R_{cd}}\right)} \times \frac{1}{1 + \dfrac{R_x}{Z_g}} \times C_s$$

$$\therefore \frac{\delta \theta}{\delta E_x} = \frac{G_m}{2\left(1 + \dfrac{R_G}{R_{cd}}\right)} \cdot \frac{1}{1 + \dfrac{R_x}{Z_g}} \times C_s$$

Rearranging the expression, we obtain

$$\frac{\delta \theta}{\delta E_x} = \frac{G_m}{1 + \dfrac{R_x}{Z_q}} \times \frac{C_s}{1 + \dfrac{R_G}{R_{cd}}}$$

The second factor is a function of the galvanometer constants only and the first of the valve constants and cell resistance.

An important property of screen grid tubes is that by adjusting the voltage of the screen grid the internal grid filament impedance may be greatly increased with a much smaller decrease in the value of the mutual conductance, and when using such tubes the optimum conditions for operation should be determined experimentally.

THE ADVANTAGES OF THE TWO-VALVE BRIDGE ARRANGEMENT.

Compensation for all battery changes, and also, in a large degree, compensation for aging of the filaments, may be readily arranged.

With quite ordinary valves the grid current may be kept as low as 10^{-8}–10^{-15} amp. as compared with 10^{-14}–10^{-16} amp. for electrometer valves (21). Stadie (11) gives 10^{-14} amp. for his instrument.

These instruments are stable and easy to handle compared with valve electrometers (Stadie (11) and Hoare (21)).

The limit of useful accuracy is 10^{-4} volt compared to 5×10^{-5} for the valve electrometer (21).

The valve sensitivity may be as high as 2·5 MA/volt compared with 0·02–0·03 MA/volt for electrometer valves (21).

SOME PRACTICAL CONSIDERATIONS.

The first matter which should be considered is the relative value of different insulating materials. The highest possible insulation value is required for any material supporting apparatus between the glass electrode and the grid of the valve in the electrometer. It is of importance to consider both surface resistivity as well as volume resistivity.

The following table gives both the volume and surface resistivity of some materials likely to be useful.

TABLE OF RESISTIVITIES.

Material.	Vol. Res. ω/cm^3	Surface Res. ω/cm^2 50% humidity.	Surface Res. ω/cm^2 90% humidity.
Ceresin	$>5 \times 10^{18}$	$>5 \times 10^{17}$	$>10^{17}$
Paraffin (special)	$>5 \times 10^{18}$	9×10^{15}	6×10^{15}
Amber	5×10^{16}	6×10^{14}	10^{11}
Combustion tubing	8×10^{15}	4×10^{12}	10^{9}
Mica (colourless)	2×10^{17}	2×10^{13}	8×10^{9}
Mica (India Ruby)	5×10^{17}	10^{10}	9×10^{7}
Beeswax	10^{16} to 3×10^{18}	....	.
Porcelain (glazed)		2×10^{12}	5×10^{8}
Quartz (fused)	$>5 \times 10^{18}$	3×10^{12}	2×10^{8}
Shellac	10^{16}	5×10^{13}	6×10^{9}
Sulphur	10^{17}	7×10^{15}	10^{14}
Beeswax (yellow unrefined)	2×10^{15}	6×10^{14}	5×10^{14}
Bakelite L558	2×10^{16}	8×10^{15}	8×10^{14}
Rosin	5×10^{16}	5×10^{14}	2×10^{14}
Sealing wax	8×10^{15}	2×10^{15}	9×10^{13}
Tetrachlornaphthalene	5×10^{13}	10^{14}	10^{14}

The grid terminal of the valve in the measuring circuit also needs careful attention. A valve should be chosen in which this terminal is placed at the top of the valve. In order to reduce surface leakage over the glass envelope of the valve it should be coated with paraffin wax (9). Surface leakage may also be reduced by placing a guard ring around the envelope just above the bakelite base

(a few turns of copper wire) and applying to the guard ring the same potential as is applied to the valve grid (16). The method of placing the valve in a jar with P_2O_5 to keep it dry and bringing out leads through a rubber stopper (17) will only increase the leakage current, as rubber is a material having poor resistivity values and further the leads are thus brought close together.

The switch in the grid circuit requires careful consideration. The insulation must be of the highest order, and this means using some material such as ceresin, paraffin or sulphur for the mounting. When using high anode voltages for the bridge, as for a deflection instrument, it is essential that the grid circuit should never be open during switching or a destructively high current will flow through the valve. This may be avoided by making the contact arm wide so that it is always in contact with one of the studs, either one connected to the low resistance cell or one connected to a grid leak. When changing cells, etc., the grid circuit should first be closed by switching in a resistance of a couple of $M\omega$ (*e.g.*, a grid leak). The cell being measured is only momentarily shorted through this comparatively high resistance.

High value grid resistances are best made by drawing a line 1 mm. wide and of length 1 cm. for each $M\omega$ of resistance with Higgin's India Ink on smooth onion skin paper. The resistances should be sealed in tubes of dry air, or evacuated tubes. For high resistance values the line is drawn in the form of a grid (Fig. 16). These resistances have been found perfectly satisfactory (16, 18) and to have a lower temperature coefficient of resistance than the alcohol Xylol resistances of Campbell (19).

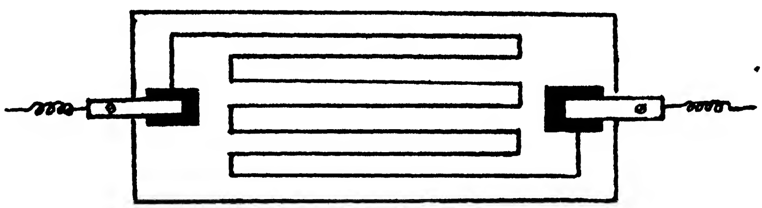


FIG. 16.

The following measurements of temperature coefficients are taken from Nottingham's paper (16):—

$$R_t = R_{23}[1 + \alpha(t - 23)]$$

R_{23} in ω.	α
$0 \cdot 85 \times 10^6$	$-2 \cdot 7 \times 10^{-3}$
750×10^6	$-6 \cdot 4 \times 10^{-3}$
2100×10^6	$-6 \cdot 4 \times 10^{-3}$

All potentiometers associated with circuits carrying current for the bridge should be placed in parallel with fixed resistances which should carry the main current so as to avoid disturbances in the circuit (16, 20).

As the various balancing resistances may in certain cases be carrying different currents, *e.g.*, in a direct-reading instrument, they should be made of material with a low temperature coefficient of resistance.

Special Galvanometer Shunt.

Nottingham (16) has designed a special shunt for the indicating instrument. Shunts are especially useful with direct-reading instruments. Fig. 17 shows the circuit of the Nottingham shunt.

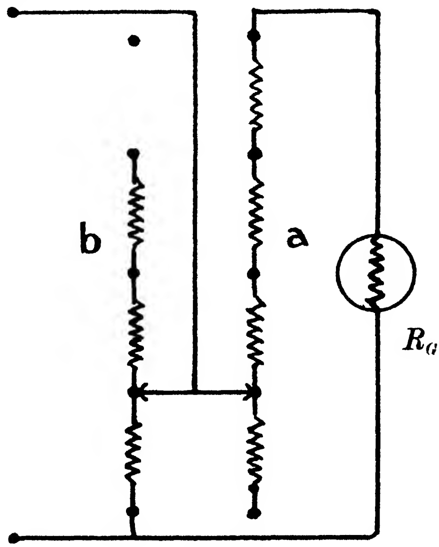


FIG. 17.

The shunt is designed so that the damping of the galvanometer is kept constant, but the current is reduced to the required percentage.

If R_{cd} = critical damping resistance

n = sensitivity ratio = $\dfrac{\text{sens. max.}}{\text{sens. n.}}$

R_a = resistance in branch *a*

R_b = resistance in branch *b*

we have the relation

$$R_a = R_{cd}\left(\frac{n-1}{n}\right)$$

$$R_b = R_{cd}\left(\frac{1}{n-1}\right)$$

The values of R_a and R_b are independent of the galvanometer resistance and the shunt is of a universal type.

The standard Ayrton shunt suffers from the minor disadvantages that—

(*a*) there are errors in the sensitivity ratio ;

(*b*) there is non-uniformity of damping ;

(c) there is loss of sensitivity.

Protection of the Indicating Instrument.

To protect the indicating instrument against break-down due to the passage of excessive current should a valve burn out, the filaments may be connected in series.

Choice of Valves.

Valves should be chosen because of their high value of mutual conductance and high input impedance. The grid terminal should be placed at the top of the tube. Dull emitter, or better still, indirectly-heated cathode valves are preferable to others because their filament emission is more constant over a long period. For a deflection or direct-reading instrument the valve should have sufficient length of straight characteristic in the operating region.

Shielding.

The instrument should be placed in a metal case which is grounded. The grid lead to the active valve should be as short as possible and conducted through a metal tube which is also grounded. Stadie (11) connects a small ($\cdot 003\mu F$) condenser between the active grid terminal and the metal case, but this seems open to some objection as the mica is not of such high resistance value as might be desired and the leakage path is of large size and short.

ACKNOWLEDGMENT.

The writer desires to express his sincere thanks to Dr. G. A. Elliott, University of W.A., for his help in checking the original mathematical proofs used in this paper.

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PURE CULTURES OBTAINABLE FROM PLANT PATHOLOGY BRANCH.

Pure cultures of the nitrogen-fixing bacteria which form nodules on the roots of certain species of the family *Leguminosae*, may be obtained, on application to the Plant Pathologist, in the quantities, and at the prices, indicated below.

APPROXIMATE AMOUNT OF SEED WHICH MAY BE TREATED WITH ONE BOTTLE OF CULTURE.

Size of bottle.	Price. (Post free) s. d.	Seed of size of lucerne or sub-clover, etc.	Seed of size of garden pea, lupin, soy beans, etc.	Milk required	Tri-calcium phosphate (Supplied free)
1 oz	1 6	Up to 15lbs	Up to 30lbs	¼-pint	1.5 gms.
2 oz	2 6	Up to 30lbs.	Up to 60lbs	½ pint	3.0 gms
8 oz	5 0	Up to 120lbs	Up to 240lbs	1 quart	12 0 gms

DIFFERENT BACTERIA REQUIRED FOR DIFFERENT KINDS OF LEGUMES.

The strains of bacteria which may be obtained from the Department will inoculate the following groups of legumes *The members of each group are inoculated by the same strain of bacteria, but the plants mentioned in different groups require different bacteria.*

Group A.—Subterranean clover, drooping-flowered clover, ball or cluster clover, white Dutch clover, perennial red clover ("cow grass"), Egyptian clover, (Berseem clover), and all other true clovers (*Trifolium spp*).

Group B—Lucerne, white sweet clover (*Melilotus indica*), "King Island Melilot" ("Hexham scent"), medics, trefoils, and all other species of *Medicago or Melilotus.*

Group C.—Garden pea, sweet pea, field pea, Tangier pea, all kinds of vetches or tares, broad bean, tick bean, lentil.

Group D.—W.A. blue lupin (*Lupinus varius*) and N. Zealand blue lupin (*L. angustifolius*).

Group E.—Soy beans (*Glycine Max*).

Group F. Sulla (*Hedysarum coronarium*).

Group G.—French beans (*Phaseolus vulgaris*), scarlet runner bean (*Phaseolus multiflorus*).

Group H.—Cow peas (*Vigna sinensis*), peanuts (*Arachis hypogoea*), Japan clover (*Lespedeza spp.*), Lima bean (*Phaseolus lunatus*).

Group J.—*Lotus major* and other *Lotus* species.

It is very important that persons ordering cultures should specify very clearly the kind of seed to be inoculated. If "pea" bacteria are ordered, for example, it is impossible to tell whether "garden" peas or "cow" peas, etc., is meant, unless the qualifying word is also indicated. The same thing applies to French and broad beans.

Full instructions for usage are enclosed with the cultures.

Owing to the time taken to prepare the cultures, and owing also to the fact that all orders have to circulate through the Accounts Branch before reaching the Plant Pathologist and that in the busy time of the year there is frequently a tremendous accumulation of orders, farmers are requested to lodge their applications, with the requisite payment enclosed, at the Department a fortnight at least before they wish to use the culture.

RECENT EXPERIMENTS WITH "MINOR" ELEMENTS IN WESTERN AUSTRALIA.

(A series of four short papers.)

I. A brief review of the "minor" element question in Western Australia.

II. Experiments with "minor" elements on the growth of potatoes, vegetables and pastures.

III. Response of wheat to copper on light land at Wagin.

IV. The effect of "minor" elements on the growth of wheat in other parts of the State.

I.—A BRIEF REVIEW OF THE "MINOR" ELEMENT QUESTION IN WESTERN AUSTRALIA.

By L. J. H. TEAKLE,
Department of Agriculture.

Probably the most characteristic features of the soils of the agricultural areas of Western Australia is their extreme patchiness. This may be explained by a consideration of the possible geological history of this portion of the State where the country rocks consist of a mass of very ancient rocks including altered sediments and granites intersected with basic dykes. The forces of erosion planed down the surfaces to a gently undulating plain and, in the course of time, there developed a covering of highly leached sandy, and ironstone gravelly, soils which we commonly call laterite. In recent times further erosion took place and large valleys were cut through this plain exposing the country rock. The gravelly soils were washed away or redistributed in the course of the valley formation and the granites, sediments and basic rocks exposed to soil forming agencies. As a result, the most fertile soils of Western Australia occur in the valleys, and are richest where the basic dykes have been exposed. Over the agricultural areas the sands and gravels, either *in situ* or redistributed, predominate. The soils formed on these materials are of low fertility and the existence of sub-optimal nutritional conditions is to be expected. These conditions are reflected by the plant growth and by the response of the grazing animals to the pastures on which they graze.

Except for favoured areas of limited extent early settlers found it difficult to grow crops without liberal fertilisation. They used animal manures as far as possible and guanos were applied where available. In the Albany district, they are reported to have used decayed fish on a small scale.

It was the introduction of superphosphate about 1908 which really made extensive agriculture possible in Western Australia, and the resulting development has led to the discovery that other soil amendments are needed on some soil types. Strangely enough, potash and nitrogen have proved valuable only under restricted conditions, but in certain districts the so-called "minor" elements have recently given remarkable responses with crops and animals and promise to be of considerable importance in Western Australian agriculture.

Until about 20 years ago it was thought that only about 10 elements were necessary for the growth of crops and of these the soil supplied seven, namely, calcium, magnesium, potassium, iron, nitrogen, phosphorus, and sulphur. During

the next ten years plant physiologists discovered that a number of other elements were required for plant growth, but they were required in very small amounts; such small amounts that they were called "minor" elements. For a time these minor elements were regarded as laboratory curiosities rather than of practical importance, but now a number are required under field conditions in all parts of the world to maintain the healthly growth of crops and are used as regular fertiliser applications. Amongst the most important of these "minor" elements are copper, manganese, zinc and boron.

The deficiency of a "minor" element in a soil for any particular crop is generally associated with subnormal growth, chlorosis, and other symptoms of malnutrition. Symptoms vary with the crop, the element concerned and the severity of the deficiency so that considerable experience is necessary for diagnostic purposes. Overlapping of the symptoms frequently occurs and makes diagnosis more difficult.

Examples of important responses to "minor" elements in Western Australia may be recalled.

(1) *Copper.*

The Young brothers of Young's Siding, near Albany, remember using bluestone for the growth of oats about 60 years ago. Wickens (1924) and Pittman (1936) have pointed to the use of copper for the cure of exanthema of citrus, Japanese plums and apples. Pittman (1935) has found mottle leaf of figs to be controlled by means of copper. More recently, Bennetts (1937) has shown enzootic ataxia of sheep at Gingin to be related to copper deficiency, and observations in the Dandaragan district indicate a widespread occurrence of copper deficiency with respect to oats. Dunne (1938a), (1938b) has found copper to be effective in controlling "wither tip" of apples.

The results reported in subsequent papers of this series will show that copper promises to be of considerable advantage on certain acidic soil types in the Albany district and at Wagin. A variety of crops shows marked response and with copper sulphate included in the fertiliser mixture, certain characteristic symptoms are eliminated and it will probably be possible to produce a new range of crops on a number of important soil types.

(2) *Manganese.*

Carne (1927) first recognised the grey speck disease of oats in the Dwarda district. Subsequently a survey made by Teakle, Thomas and Hoare (1933) showed that manganese deficiency was probably not widespread in Western Australia. However, conditions under which manganese deficiency does occur have been described by Wild (1934) and Adams (1937). These writers show that cereals are liable to need manganese fertilisation on somewhat acidic, powdery, gravelly soils of the 15 to 25 inch rainfall belt. Legumes are more tolerant of manganese deficiency than cereals.

In the present experiments the most important responses to manganese appear on marly peats. For certain crops on these types, copper in addition to manganese may be required.

(3) *Zinc.*

The value of zinc in Western Australia for promoting the growth of crops was shown by Pittman and Owen (1935), who found that zinc sprays would cure mottle leaf of citrus. Kessell and Stoate (1938) described the remarkable effect of zinc

in stimulating the growth of unhealthy pines affected by "rosetting" on the coastal sands south of Perth. Hearman (1938) reported that pines affected by "rosetting" were stimulated, also, by injection of manganese sulphate, ferrous sulphate, cobalt chloride, nickel chloride, sodium molybdate and boric acid.

No beneficial effects from zinc have been observed in the experiments reported in the subsequent papers but severe injury to wheat resulted from the use of zinc sulphate at the rate of 20 lbs. per acre on the Wongan Hills Research Station.

(4) *Cobalt.*

Underwood and Filmer (1935) (1936) succeeded in showing that minute quantities of cobalt were curative of the Denmark wasting disease of cattle and sheep. The incidence of the disease is correlated with a low cobalt status of the soils and pastures (Harvey (1937), Underwood and Harvey (1938)).

The evidence reported in the subsequent papers of this series shows that "minor" element deficiencies in soils appear to be associated with the "deterioration" of potato seed in the Albany district and the rapid decline in the yield of potatoes after a satisfactory first crop on certain soil types in the same locality. Furthermore, the failure of efforts to establish certain crops and pasture species on certain soils is undoubtedly due to inadequate supplies of available "minor" elements of which copper is of prime importance. The evidence from Wagin suggests that many cases of wheat failure and the development of white heads on gravelly sandy soils may be improved by the use of copper salts.

Conclusion.

The observations reported in this paper are published at the present juncture on account of the widespread interest of farmers in the use of "minor" elements in Western Australia. It is true that very spectacular results from the use of a number of "minor" elements have been obtained and there is no doubt that further experimentation and survey will establish the value of certain of these constituents under many conditions of Western Australian agriculture.

But it is not to be supposed that the mere use of small quantities of "minor" elements will revolutionise Western Australian agriculture. The majority of our soil types at present under cultivation are probably adequately supplied in these constituents at least for the immediate future and experiments are reported in which no benefits have resulted. In fact, it is evident that even small quantities of some "minor" elements may be distinctly injurious to wheat and other crops under certain conditions. Indiscriminate application of these fertilisers by farmers is ill-advised and will certainly lead to loss of money and, perhaps, to reduction in crop yield under many circumstances.

However, advantage must be taken of the positive results which do give promise of enabling farmers to develop considerable areas of virgin country in settled areas under a generous rainfall and of improving crop and pasture returns and, incidentally, the nutrition of the grazing animals on many soil types. On some soil types the use of copper and of manganese promises to retard soil "deterioration" and simplify farm management: to avoid the need for potato seed introduction and the consequent hazard of disease dissemination Certain of these "minor" elements promise to promote the growth of crops and pasture species where these had failed under ordinary farm practice.

There is strong evidence of the value of manganese on marly peats and of copper on certain types of acidic peaty sands and mucks in the Albany area: of copper for wheat on types of gravelly sand in the Wagin district. It is necessary

to extend the research programme to determine by survey and experiment the conditions under which response is likely and the crop symptoms which will indicate possible deficiencies.

In the absence of more precise information farmers are advised to use great caution in the use of "minor" elements. Rates should be kept low—not more than 15 lbs. per acre should be adequate under most conditions. Until experience has been obtained small areas should be treated for comparison with crops grown under ordinary conditions as without comparisons no conclusions may be drawn in most cases. Above all, farmers are advised to carry out tests with "minor" elements on their farms only after receiving the advice of the Department of Agriculture. By this means the risk will be minimised and any information obtained may be propertly evaluated and used for the benefit of other agriculturists.

II.—EXPERIMENTS WITH "MINOR" ELEMENTS ON THE GROWTH OF POTATOES, VEGETABLES AND PASTURES.

By L. J. H. TEAKLE and E. T. MORGAN,
Department of Agriculture.

1. *Introduction.*

The failure of various crops to make satisfactory growth in spite of suitable climatic conditions and generous fertiliser treatment on soils of favourable physical properties has led to much successful work with "minor" elements all over the world. Successes with these amendments in Western Australia have already been mentioned in Paper I. and it is the purpose of this communication to give the results of further experiments with potatoes, vegetables and pastures.

The first indication of the possible lack for the growth of potatoes of some other constituent than is usually applied in mixed fertilisers came from the apparent need for very heavy dressings of superphosphate (10-12 cwt. per acre) for maximum returns. Further evidence was provided by the "deterioration" of potato seed in some localities, the "deterioration" of certain types of potato land, the occurrence of "thready" eye and similar weaknesses in the tubers, and unthrifty growth of tops under some conditions. The failure of various truck crops on certain soils and difficulties in pasture establishment pointed to undetermined soil deficiencies.

In early experiments with potatoes disappointing results were obtained. Palmer (1933), using copper sulphate in the fertiliser mixture for potatoes, found a slight response on the Herdsman marly peat. Morgan (1938) found no response to a mixture of copper, manganese, zinc and magnesium at Burekup on the western coastal plain, near Bunbury. This finding may be explained by the results of spectrographic analyses made by Professor N. S. Bayliss, of the University of W.A. The pulp of a potato grown at Benger (Mr. T. Offer), a little north of Burekup, showed a high content of "minor" and other elements (copper, boron, manganese, iron, cadmium, barium, sodium and cobalt) as compared with samples from Young's Siding (Mr. E. Smith and Mr. R. Wolfe), in which district marked responses have now been obtained.

2. *Responses on marly peat soils on Mr. B. H. Burvill's property, Little Grove, Albany.*

The first responses of significance were observed in the Albany area where, in the 1936-37 season, Mr. B. H. Burvill tested the effect of manganese on a number of truck crops grown on a marly peat soil at Little Grove.

Although the first crops grown after clearing these swamps did fairly well, the succeeding ones were failures for no apparent reason. Resemblance of the soil to certain types described on the Florida Everglades prompted the application of manganese sulphate to potatoes, beans and cabbages. The result was very gratifying with all crops, but particularly outstanding with beans. Later it was observed that manganese sulphate was of benefit also to swedes, turnips, tomatoes and peas, and that copper sulphate, in addition to manganese, improved the cabbages, swedes, turnips, tomatoes and peas. The particular value of copper to peas lay in the formation of well filled pods instead of the usual "puff boxes" or empty pods when only H manure* was used.

In the 1937-38 season experiments on this type of soil were organised by the Department of Agriculture to get more precise information with a number of crops. Yields of potatoes are given in Table 1.

TABLE 1.

Yields of potatoes on marly peat soil on Mr. B. H. Burvill's property, Little Grove, Albany. "Minor" elements, except boron, were applied as commercial sulphates at the rate of 20 lbs. per acre.

Fertiliser.	Yield per acre.		Per cent. of Control.
	tons.	cwt.	
Control—Manure E†	6	0	100
Plus magnesium sulphate	5	9	91
„ copper sulphate	5	14	95
„ zinc sulphate	7	3	119
„ borax (20 lbs. per acre)	6	16	114
„ manganese sulphate	8	10	142
„ manganese sulphate, copper sulphate ...	8	12	143
„ manganese sulphate, copper sulphate, zinc sulphate	9	9	158
„ manganese sulphate, copper sulphate, zinc sulphate, magnesium sulphate, borax	8	8	140

Significant difference is 1 ton 3 cwts. per acre ($P = 0.05$).

The only really significant response with potatoes was to manganese. It was noted, however, that copper improved the colour of all crops treated.

With swedes and cabbages growth was greatly improved by both copper and manganese but no harvest returns were obtained. Mr. Burvill reported that swedes grown with copper and manganese were ready to pull at least a fortnight earlier than the controls. Beans did not mature on account of frost but showed early response to manganese.

In the 1938-39 season a commercial crop of swedes was sown on the site of the experiment with beans. A marked residual effect due to the minor elements was observed but the individual plots had lost their identity in ploughing.

A complex 3 x 3 x 3 x 3 factorial experiment with potatoes was arranged for 1938-39. It was planted during the first week in December but headway was slow owing to the dry early summer conditions. Top growth reflected the treatments,

* Manure H has the following composition: 4% nitrogen, 13.7% P_2O_5 and 9% K_2O.

† Manure E contains 3.5% N, 15% P_2O_5, and 8% K_2O.

however, and showed marked improvement on all plots receiving manganese either at the rate of 20 lbs. per acre or 40 lbs. per acre. Copper, zinc and boron were without apparent effect. Without manganese the plants were stunted and showed a bronze yellow chlorosis, particularly between the veins. With manganese the plants were a normal green and promised a fair yield until destroyed by floods on 13th January, 1939. The area has been sown with oats to determine the residual effect of the treatments on this crop, and a similar experiment is planned for the coming season.

3. *Responses on acidic swamp soils on Mr. C. T. Hortin's property, Bornholm.*

The deterioration of locally grown potato seed in the Albany district has caused great concern and, in many instances, necessitated the introduction of seed from other districts, for example, Benger on the coastal plain south of Perth. The introduction of seed from other districts complicates potato growing and is undesirable on account of the spread of diseases.

Fig. 1 shows the relative growth from local and Benger seed on sandy swamp karri land on Mr. E. Cake's property, Young's Siding.

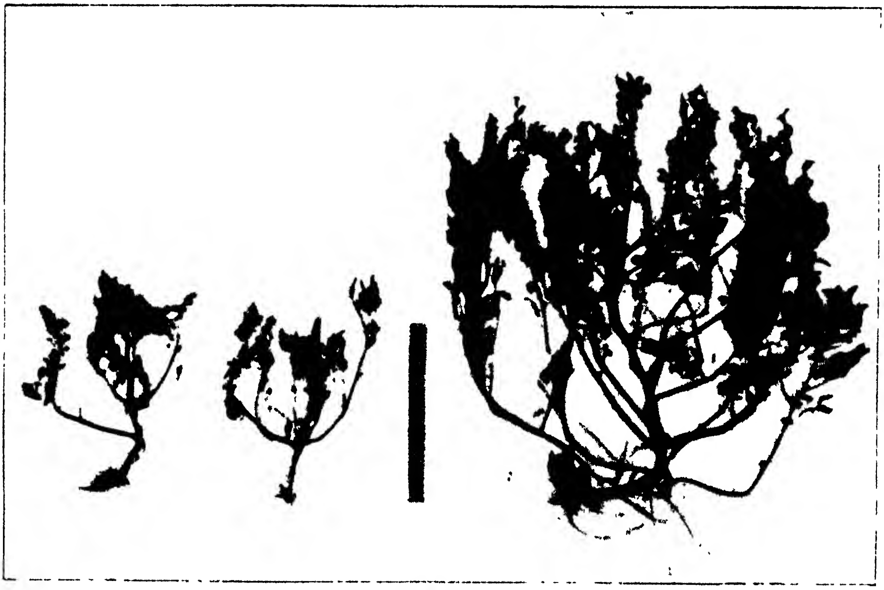

Fig 1

Potato tops from Mr. E. Cake's farm, Young's Siding, without "minor" element treatment. Left two plants from local seed. Right one plant from Benger seed.

Photo. L. J. H Teakle

The first indication of the benefit from minor elements in maintaining the vigour of Albany seed arose from an experiment on Mr. C. T. Hortin's swamp at Bornholm in the 1937-38 season. The soil is a black acidic muck to sandy muck (pH 4.2) and very productive but gave marked increases in yield as a result of using minor elements. In the preliminary experiment, a mixture of "minor" elements consisting of commercial sulphates of copper, manganese, zinc and magnesium and borax each at the rate of 20 lbs. per acre was used with a "complete"* fertiliser compounded from 5 parts of superphosphate, 1 part of sulphate of ammonia, and 2 parts of sulphate of potash.

* A "complete" fertiliser contains nitrogen, phosphorus, and potassium.

The results of the experiment are given in Table 2.

TABLE 2.

Effect of minor elements on the growth of potatoes on Mr. C. T. Hortin's swamp, Bornholm.

Fertiliser.	Yield per acre. tons.	Yield per acre. cwt.	Per cent. of Control.
"Complete" fertiliser—8 cwts per acre ...	9	13	100
"Complete" fertiliser—16 cwts per acre ...	11	10	119
"Complete" fertiliser—8 cwts per acre, plus "minor" elements	12	18	134
"Complete" fertiliser—16 cwts per acre, plus "minor" elements	13	12	141

The minor element mixture materially increased the yield, reduced the need for heavy dressings of "complete" fertiliser and, in addition, eliminated the appearance of "stem end" rot in the tubers.

Fig. 2 shows the comparison of tubers from plots with and without "minor" elements.

Fig 2.

Potatoes from Mr. C. T. Hortin's experimental area, Bornholm, harvested April, 1938. Top row smooth, blocky tubers with vigorous eyes from plots receiving "minor" elements. Bottom row rough, pointed tubers with scaly skin from plots receiving no "minor" elements.

Photo.: Government Printer.

Immediately following the digging of the potatoes oats were sown on the experimental area in March, 1938. Spectacular growth was made on the sites

of the minor element plots. The plants were erect, tall, green and vigorous and the leaves showed a prominent mid-rib. Over the rest of the area the symptoms suggested that copper was the active ingredient as they closely resembled those described by Riceman and Donald (1938). The plants were yellowish tipped, weak in the stem and poorly rooted. Weighings indicated that the treated areas would yield about 11 tons of green material per acre while only 2 tons could be expected from the land which had not received minor elements.

Fig. 3 shows the growth of oats with and without "minor" elements.

Fig. 3

Growth of oats on Mr C. T. Hortin's experimental area, Bornholm, 1938. Left without "minor" elements—14 ozs. green material. Right with "minor" elements—84 ozs. green material. Photo E. T. Morgan

A more critical 3 x 3 x 3 x 3 factorial experiment was planted on adjacent land of the same type in the first week of December, 1938, and the growth of the tops observed five weeks later at the beginning of flowering. As the characteristic improvement in top growth occurred only on the plots treated with copper it was apparent that copper was the most important active ingredient in the mixture used the previous year.

The floods of 13th January, 1939, wiped out the crop so no harvest returns are available.

Fig. 4, on following page, shows the effect of the flood on the potato crops.

An oat crop has been sown to determine the residual effect of the treatments.

The effects of copper on potatoes grown on copper deficient land are: the foliage is more vigorous and the leaves a paler green colour than in the controls, the stems are thicker and more erect, and there is a strong development of branches and subsidiary stems, flowering is more profuse and prolonged. As shown in Fig. 2, the tubers are cleaner, healthier and of better quality, the eyes are stronger and more deeply set, and the "eyebrow" is more pronounced. On sprouting, vigorous pink shoots are produced and the succeeding crop reflects the extra quality of the seed from the plots receiving copper.

4. *Responses on other soils of the Bornholm and Young's Siding districts.*

The results with potatoes and oats so impressed farmers of the Albany district that several tons of bluestone were used during 1938 on a variety of crops and soil types. In the majority of cases very satisfactory responses were obtained from dressings ranging from 8 to 15 lbs. of copper sulphate per acre.

a. Mr. C. T. Hortin's property, Bornholm, 1938.

On a brown sandy soil, about 3 feet in depth, on a karri hill, barley was greatly improved by a top dressing with powdered bluestone at the rate of 15 lbs. per acre. Without copper, and in spite of a dressing of potato manure, the barley was poorly rooted and easily pulled up, the stems weak and prostrate, the sheaths pale and the leaves showed a whitish or yellowish tipping and yellow edging. With copper, in spite of an initial burning, normal growth was made. Likewise, garden peas dressed with potato manure (5 super., 1 sulphate of ammonia, 1 blood and bone, and 2 sulphate of potash) plus copper sulphate produced excellent well filled pods.

Fig 4.
Effect of flood water on a good crop of potatoes on C. T. Hortin's swamp Experiment area.

Without copper, the plants made normal vegetative growth but the pods failed to fill. Onions and lettuce planted subsequently made satisfactory growth on this land when copper was used whereas in earlier years they had failed completely. Runner beans grown without copper on similar soil showed small yellowish leaves with burnt edges, and flowers were sparse on stunted plants only 2 feet tall at the time of inspection. In the case of those treated with copper, the plants were 3 feet tall, the leaves were of normal size and of good colour and flowers were numerous.

Copper sulphate has been so beneficial on this property that Mr. Hortin is now using it generally on his cropped land.

b. Mr. J. Wolfe's property, Bornholm, 1938.

The results on Mr. Hortin's property led Mr. J. Wolfe to conduct some tests on his adjoining farm. An experiment on a virgin wet heath soil of the Plantagenet peaty sand type (described by Hosking and Burvill (1938)), and known locally as bottle brush country, showed that an excellent stand of subterranean clover, cocksfoot, prairie grass, and other pasture species was obtained if dressed with copper sulphate at the rate of 15 lbs. per acre. The surface heath and fibrous surface soil was merely broken to a depth of about 4 inches with a heavy plough, burnt as soon as dry, and sown down in the autumn with the pasture mixture and copper sulphate without superphosphate. Improved growth resulted on an area where superphosphate and ammonia were applied in the following spring. Without copper sulphate a very inferior growth of *Lotus major* and Yorkshire fog resulted as other species failed to grow past the seedling stage.

This type of land covers extensive areas along the south coast. Sir John Russell, on the occasion of his inspection of the area on 26th January, 1939, stated that this soil type, the Plantagenet peaty sand, resembled those of Holland on which reclamation disease occurs and where copper sulphate has proved beneficial for crops and stock.

Early efforts to establish pastures on this type of country met with indifferent success with the usual fertiliser mixtures. Baron Hay (1933) describes the methods adopted for development and records the failure of the pasture even where a "complete" fertiliser is used. Yorkshire fog was the most promising species tried. The discovery of the effect of copper sulphate now promises to improve the prospect for pasture establishment on this soil type. Even Yorkshire fog, which is very tolerant of copper deficiency, requires top dressing with copper sulphate on this soil type on Mr. Wolfe's property to maintain a sound rooting system and firm crown.

On some sandy loam soils of karri hills on the same property, some 7 acres of pasture were dressed with copper sulphate at the rate of 8 lbs. per acre in 1938. The pasture was a good sward of perennial rye grass, paspalum and subterranean clover. It appeared to benefit from the copper sulphate and Mr. Wolfe believes that the stock, brought in from the coastal sandhills, improved in condition more rapidly than usual and showed some preference for the treated pasture.

Tomatoes apparently respond to copper sulphate on the Plantagenet peaty sand types. Planted with the usual potato manure tomatoes failed to grow and developed a bunchy habit with yellow foliage. When watered with dilute copper sulphate solution excellent growth and fruiting resulted.

Mr. J. Wilkinson of the same district has made similar observations. He found that about 2 ounces of copper sulphate per gallon of water was the maximum usable without injury to the plants.

Mr. Wilkinson has also observed that Wimmera rye grass will grow normally on certain of these poor sandy soils if dressed with copper sulphate.

c. Observations on Saidie Swamp, Young's Siding, 1938-39.

The sandy swamp karri soils of Saidie swamp have been found to yield a satisfactory first crop of potatoes, but "deteriorate" rapidly with subsequent cropping. This "deterioration" may be avoided by the use of seed grown in Benger Swamp or on strong soil types of other districts (see Fig. 1.) and preliminary results indicate that the use of copper sulphate at the rate of 15 lbs. per acre will

accomplish a similar result. During the 1938-39 season Mr. Kurt Martin has obtained excellent growth of potatoes on "deteriorated" land as a result of using copper sulphate with the usual fertilisers. Seed from plots which had received copper seemed to give a better response than those from areas not treated with copper, probably owing to an improved tuber resulting from the treatment. Manganese and zinc, in addition to the copper, may be beneficial.

Fig 5

Growth of local and Benger seed with and without "minor" elements on Mr. E Cake's farm, Young's Siding. Right pair local seed without "minor" elements Middle pair, local seed with 16 lbs per acre each of copper sulphate and manganese sulphate. Left pair Benger seed with similar treatment to middle pair Photo L J H Teakle.

Fig. 5 shows the top growth from local seed, local seed plus copper and manganese, and Benger seed. The Benger seed has produced the most vigorous top growth but no yield comparisons will be available on account of destruction by the floods of 13th January.

Cabbages on similar soil on Mr. E. Cake's adjoining property produced marketable heads only where copper was used. Without copper growth was poor and the lower leaves were pale yellow in colour and of a papery consistency. Mr. J. Wolfe has observed similar responses with copper.

d. Observation on Mr. J. T. Rutherford's holding, Torbay, February, 1939.

From the observation of Mr. G. K. Baron Hay (private communication) it seems that maize will grow on the Plantagenet peaty sand type where small dressings of copper are used. Mr. Rutherford ploughed an area of this wet, semi-bottlebrush country and allowed it to lie fallow over the winter of 1938. In spring it was worked down and sown to maize with superphosphate and superphosphate plus ammonia. By way of an experiment, four rows received copper sulphate at the rate of 6 lbs. per acre with superphosphate. At the end of February, 1939, where the copper was used, the maize was 4 to 6 feet tall, uniformly vigorous and a good green colour. Elsewhere, except at the sites of fires, the plants generally had

grown to a height of only one foot and were yellow in colour and dying or dead. It is interesting that on the sites of fires the growth of the maize equalled that of the copper treated rows.

5. *Experiments on Mr. F. Wittenoom's property, Maida Vale.*

On account of unsatisfactory yields of potatoes on an acidic peaty sand on Mr. F. Wittenoom's property, Maida Vale (10 miles east of Perth), a randomised block experiment with potatoes was arranged. The land was planted on 8th and 9th August and harvested on 28th November, 1938. The growth throughout the period was never vigorous and there were no obvious responses to treatment. Irish blight caused some loss and soil conditions proved harmful in certain small patches.

The results of the experiment are given in Table 3.

TABLE 3.

Yield of potatoes on Mr. F. Wittenoom's farm, Maida Vale. All "minor" element salts applied at the rate of 20 lbs. per acre. Control mixture consisted of sulphate of ammonia (4 cwts. per acre), superphosphate (12 cwts. per acre), sulphate of potash (2 cwts. per acre).

Treatment.	Yield per acre.		Per cent. of Control.
	tons.	cwts.	
Control	10	5	100
Control plus zinc sulphate	9	12	94
.. .. borax	9	9	92
.. .. manganese sulphate . ..	9	8	92
.. .. copper sulphate	9	14	95
.. .. copper sulphate, manganese sulphate, zinc sulphate, magnesium sulphate, borax	9	3	89

As the mean square for error exceeded that for treatment, there is no significant difference between any of the treatments and it must be concluded that the "minor" elements did not affect the growth or yield of potatoes on this land.

The marked response of potatoes to "minor" elements on a number of soil types in the Albany district along the south coast and the absence of response along the west coast (where, incidentally response to potash is obtained) are probably correlated with differences in the composition of the rocks of the two localities. Mr. F. G. Forman, the Government Geologist, has observed that the rocks of the Darling Range are much richer in minerals than those along the south coast and it is reasonable to conclude that the mineral composition of the associated soils would reflect similar differences.

It is interesting, too, that with the exception of one instance on Mr. J. Wolfe's property, no responses have been observed to the treatment of *established* pastures with copper, manganese and zinc in a number of cases in the Albany district, on the Denmark Research Station, at Manjimup and in the Busselton areas. Of course, it seems likely that *established* pastures have become adapted to the environment and will not ordinarily respond to treatment with "minor" elements. Responses may be detected only when attempts are made to develop more desirable species which require a more generous supply of certain factors. However, such spectacular responses as have been reported cannot be expected to be very general except in certain localities and on certain soil types.

In those areas apparently copper deficient, general observations indicate that plants apparently tolerant of copper deficiency include Yorkshire fog (*Holcus lanatus*), drooping flowered clover (*Trifolium cernuum*), Lotus major, rye (*Secale cereale*) and millet. Plants which appear to be most responsive to copper applications on deficient soils are wheat, oats, barley, turnips, swedes, cabbages, lettuce, peas, beans, tomatoes, onions, cocksfoot (*Dactylis glomerata*), prairie grass (*Bromus unioloides*), and wimmera rye grass (*Lolium rigidum* var *subulatum*).

6. *Conclusions.*

From the results of experiments reported above it may be concluded that—

(a) On marly peat soils of coastal swamps in the Albany district manganese sulphate is likely to benefit a variety of crops, including potatoes, runner beans, cabbages, swedes, turnips, peas and tomatoes. Copper, in addition to manganese, may be beneficial with peas, swedes and cabbages.

(b) On a number of acidic soil types, including swamp soils, soils of bottle brush flats and brown sandy soils of karri hills of the Albany district, copper has proved of considerable benefit to truck crops, potatoes, and pastures.

(c) On the agricultural soils of the western coastal plain south of Perth no evidence of response of potatoes, truck crops or pastures to "minor" elements has been obtained. A geological basis for this difference is suggested.

(d) It does not seem necessary to use copper sulphate or manganese sulphate at a rate in excess of 15 lbs. per acre and lower rates may be adequate.

(e) The residual effect of "minor" elements in the soil is observed in the growth of the crop grown in the following year.

To be continued.

AGRICULTURAL PROBLEMS.

Agriculturists, pastoralists and primary producers generally, who may be having difficulties of any kind in connection with their production activities, are invited to communicate with the Agricultural Adviser of their district of the Department of Agriculture, when information and advice will be supplied free of charge.

Where identification of plant or stock diseases or insect pests is required, full details of symptoms should be forwarded and also samples of the diseased plant, animal tissue or insect where practicable. Plant tissue intended for examination by the Plant Pathologist should be wrapped in paper and not forwarded in airtight containers, and plant specimens for the Botanist should be pressed between newspaper and dried before despatch. With regard to animal tissue for microscopic examination, this should be forwarded in a solution of 10 per cent. formalin, or if of considerable bulk in a sealed kerosene tin containing a few ounces of formalin as a preservative. Living insects should be sent in suitable containers and dead specimens in methylated spirits.

The addresses and names of Advisers are as follows:—

Albany	**H. R. Powell (Fruit); B. Williams (Dairying).**
Bridgetown	**A. Flintoff (Fruit); A. M. Tindale (Dairying).**
Bunbury	**M. Cullity.**
Geraldton	**N. Davenport (Government Buildings).**
Gosnells	**R. C. Owen.**
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This is a most useful and valuable book, not only for beginners, but to all those who keep fowls for pleasure and profit. It deals fully with all matters connected with the industry, including Breeding, Feeding (for stock birds or egg production), Incubating, Brooding and Care of Chicks, Marketing (eggs and poultry), and all matters of use to the poultry-keeper. It also fully describes symptoms of various ailments and diseases and simple treatment for same, and, as the book was written to suit *local conditions,* every poultry-keeper should have a copy by him. Price, 2s.

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RECENT EXPERIMENTS WITH "MINOR" ELEMENTS IN WESTERN AUSTRALIA.

(A series of four short papers continued from March issue.)

III.—RESPONSE OF WHEAT TO COPPER ON LIGHT LANDS AT WAGIN.

By A. M. Stewart,
Institute of Agriculture, University of W.A.,
and
L. J. H. Teakle,
Department of Agriculture, W.A.

(1) *Introduction.*

Striking response of wheat to copper sulphate, applied at the rate of 20 lbs. per acre, was obtained over portion of an area of 12 acres under experiment with various minor elements on Mr. A. M. Stewart's farm, Lake View, Wagin, and some response was evident over the whole of the copper treated plots.

Many years of agricultural experience persuaded one of us (A.M.S.) that the Great Southern soils of lower fertility are lacking in some factor or factors that are present in the red brown soils associated with the basic dykes which intersect the ancient granitic and metamorphic rocks which underlie most of the agricultural areas of the State. Stock grazing solely on the poorer classes of country do not make the growth or carry the bloom of animals grazing on the red brown loams which are the basis of much of the agricultural development of the Great Southern. Furthermore, when all the hay and oat requirements for the year for the working horses are obtained wholly from light land they do not seem to hold their condition. Moreover, crop returns on the more sandy and gravelly types, particularly after the first one or two crops, are frequently most disappointing, in spite of liberal dressings of superphosphate and infrequent cropping. Whiteheads are common and the plants have a tendency to cease growing when they reach the flowering stage. No satisfactory explanation of the cause had been determined.

(2) *Soils.*

The soils of the Great Southern Region (the Avon and Dwarda regions of Teakle (1938)) fall into three main groups: the first, second and third class lands of the Lands Department surveys, which were identified by the nature of their vegetation and observed fertility..

The first class land, which probably does not exceed 10 to 15 per cent. of the region, is a red brown loam usually associated with basic dykes and in the virgin state carries predominantly York gum (*Eucalyptus foecunda* var. *loxophleba*).

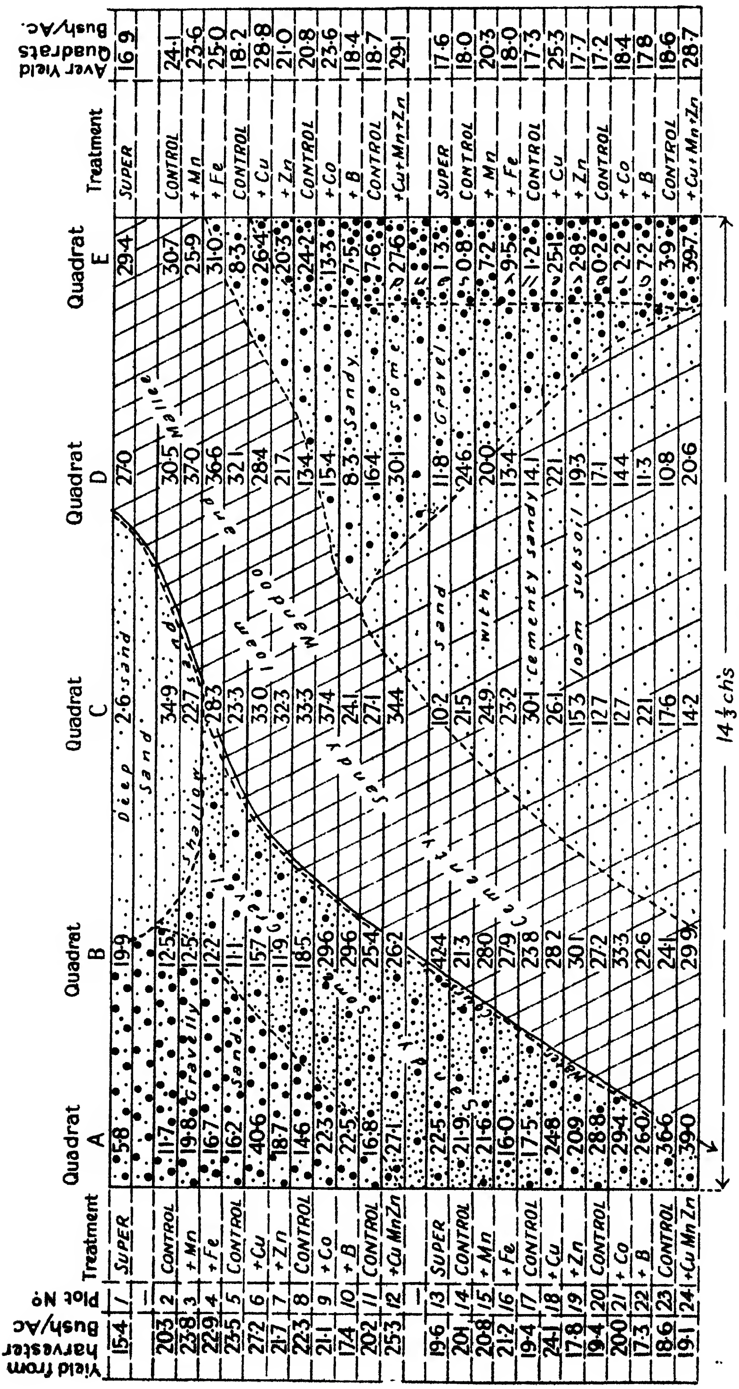

Fig. 6. SKETCH MAP OF PLOTS ON MR. A. M. STEWART'S FARM

AT LAKE VIEW, WAGIN, 1938.

Showing soil types, plot layouts, treatments & yield from harvester & quadrats in bushels per acre

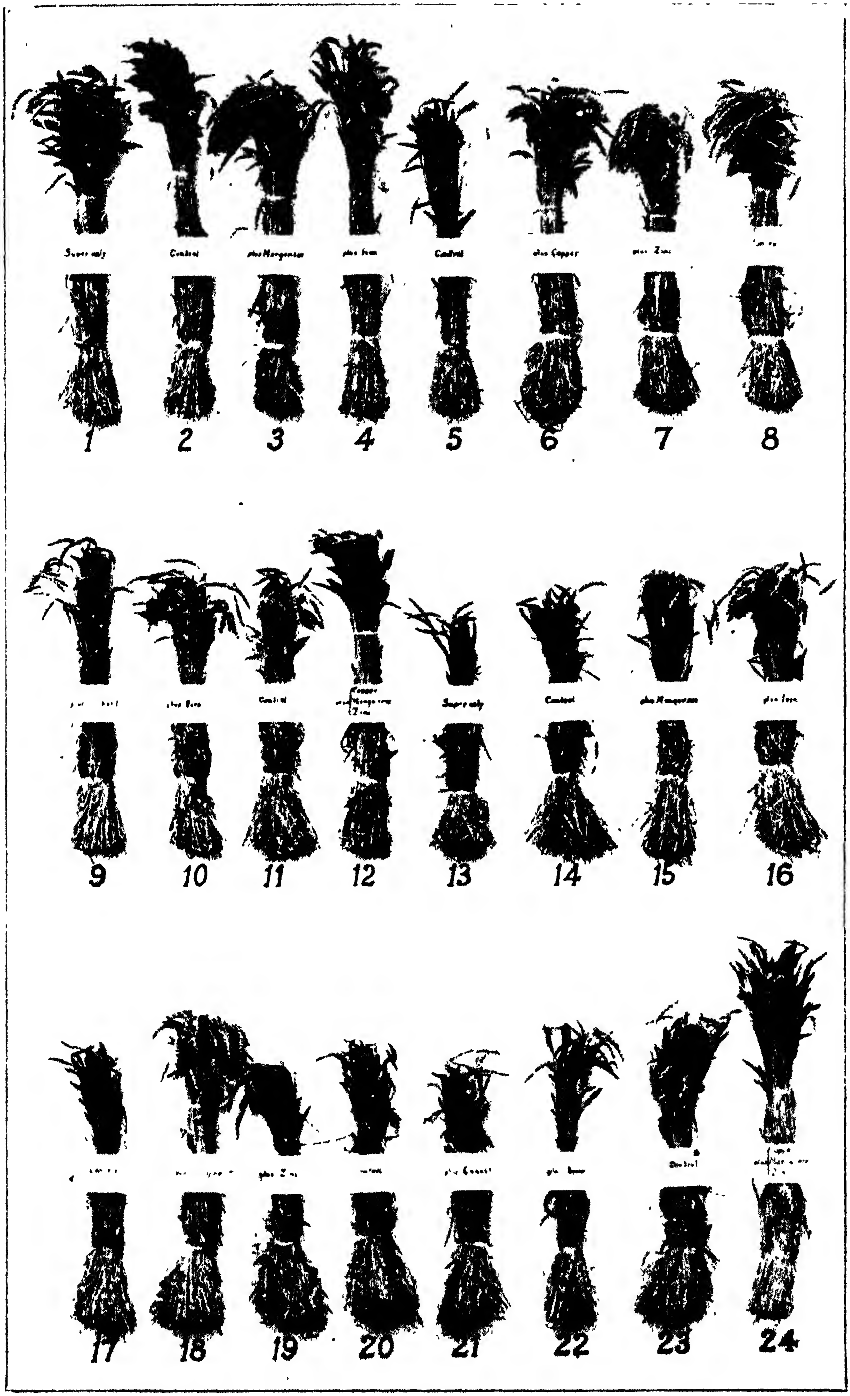

Fig. 7.

Sheaves from square yard quadrats taken on row E (Fig. 6) at the east end of the plots where the greatest responses to copper were obtained on Mr. A. M. Stewart's farm, Lake View, Wagin. (Harvested December 6th and 7th, 1938.)

Photo.: Government Printer.

The second class land, which constitutes about half of the remainder, is a grey sandy soil overlying a hard, siliceous, cementy subsoil at a depth ranging from a few inches to three feet. Below this is generally a yellowish clay, with some red mottling, which merges into decomposing acidic rocks. The characteristic timber is wandoo (*Eucalyptus redunca* var. *elata*) with which is associated jam and sheoak (*Casuarina Fraseriana*) according to the nature and depth of the surface soil.

The third class land, constituting the remainder of the area, includes laterite-capped hills, which carry wandoo, mallet (*Eucalyptus astringens*) and scrub, and extensive sandy and gravelly heath soils, or sandplains. Third class soils are usually associated with the higher land, with detritus from the lateritic hills and ridges and with residues of the laterite capping redistributed in the course of erosion.

(3) *Experimental.*

To make qualitative observations on the effects of some minor elements on some representative types of light land, an exploratory experiment with wheat* was laid down in May, 1938, using duplicated plots of 0·43 acres running across a shallow valley between two lateritic ridges. Soils ranging from poor lateritic gravelly sands (third class land) to cementy sandy loams (second class land) were crossed by the plots (see Fig. 6) and the responses to copper, manganese, zinc and iron as commercial sulphates, to cobalt chloride and to borax were observed.

The area had been cleared and farmed for at least 25 years but had not been cropped more frequently than one year in four for many years. In the virgin state the timber ranged from typical sandplain heath with blackboys (*Xanthorrhoea* sp.) on the more gravelly types at either end of the experimental area, and near the laterite ridges, to wandoo and mallee on the better cementy sandy loam soils in the lower part of the valley. A classification of the soil types is given in Fig. 6.

Nabawa wheat was sown on clean fallow in good condition on May 20th and 21st, 1938. All plots except those receiving superphosphate only, received a basal fertiliser dressing at the rate of 1 cwt. of superphosphate and ½ cwt. of sulphate of potash per acre. The minor elements were mixed with the basal fertiliser and applied by means of a combine drill with the seed in the usual way. The drill was frequently checked for rates of sowing. The layout of the plots and the treatments in relation to soil type are shown in Fig. 6.

The rainfall at Wagin during the year 1938 in comparison with the average is shown below (in points):—

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1938 ...	9	...	171	76	125	108	281	221	163	68	37	17	1,276
Average 1891–1937	31	55	96	129	224	306	301	244	186	128	46	38	1,784

One month after sowing, the copper treated strips were showing up a much brighter and healthier green than the other plots but there was no other detectable difference. Borax (10 lbs. per acre) and zince sulphate (10 lbs. per acre) had a deleterious effect.

Similar observations were made one month later.

Three months after seeding, the copper treated plots were even more outstanding. Not only was the foliage attractively green, but the plants were more erect and appeared to have less dead and brown-marked leaves at the base than those

* The fertilisers were provided through the courtesy of Cuming Smith, Mt. Lyell Farmers' Fertilisers, Ltd.

under the other treatments. Plants were dug up from all plots for spectrographic analysis and the copper treated ones appeared to have made stronger root development. The biggest response to copper occurred on the gravelly sands nearest the laterite ridges.

When examined on November 2nd, 1938, the wheat had headed and grain was forming. The copper treated plots were even more obvious, as the wheat was standing up erect, level and strong throughout and was developing well-formed, well-filled heads. The other plots were very uneven, reflecting the variations in the soil. Whiteheads were particularly common on the poorer soil types.

Fig. 7 illustrates the appearance of sheaves harvested on December 6th and 7th from square yard quadrats taken across the eastern end of the plots (Row E, Fig. 6), where the maximum response was obtained and shows the effect of the various treatments on the range of soil types. Some response to copper is visible from plots 6 to 10 but is most marked on the gravelly sandy soils (plots 11 to 24).

At maturity, on the fairly small area of poorest gravelly soil, nearly all plants, except those treated with copper, failed to mature; the straw was a purplish grey brown and the glumes of the aborted ears pale.

Fig. 8.

Looking east and showing that the effect of copper is visible over the whole length of three of the plots. The cross shadows through the middle of the picture are due to the wave of the corn and a cloud effect Mr. A. M. Stewart's farm, Wagin.

Photo.: Government Printer

Examinations of the sheaths showed that while those from copper treated plots were yellow and had the normal pearly lustre inside, on all other plots on the gravelly sand the sheaths were commonly purplish grey in colour, and exhibited a characteristic purplish lustre on the inside.

Fig. 9 shows segments of stalks from copper and non-copper plots on this soil type.

On the better soil types of the lower part of the valley, where there was little or no apparent difference in yield, it was noticed that the glumes of the heads on the copper treated plots were brown while those on the others were pale.

Fig. 8 shows that some visible effect due to copper was apparent through the whole length of the plots irrespective of soil type. The apparent darkening was due to reduced reflection of the light from the more even and erect plants on the copper treated plots and, perhaps, in part to the darker glumes.

Yields were estimated by harvesting the plots and by taking square yard quadrats from five places in each plot. By this means indications were obtained of yield fluctuations according to soil type and are represented in Fig. 6.

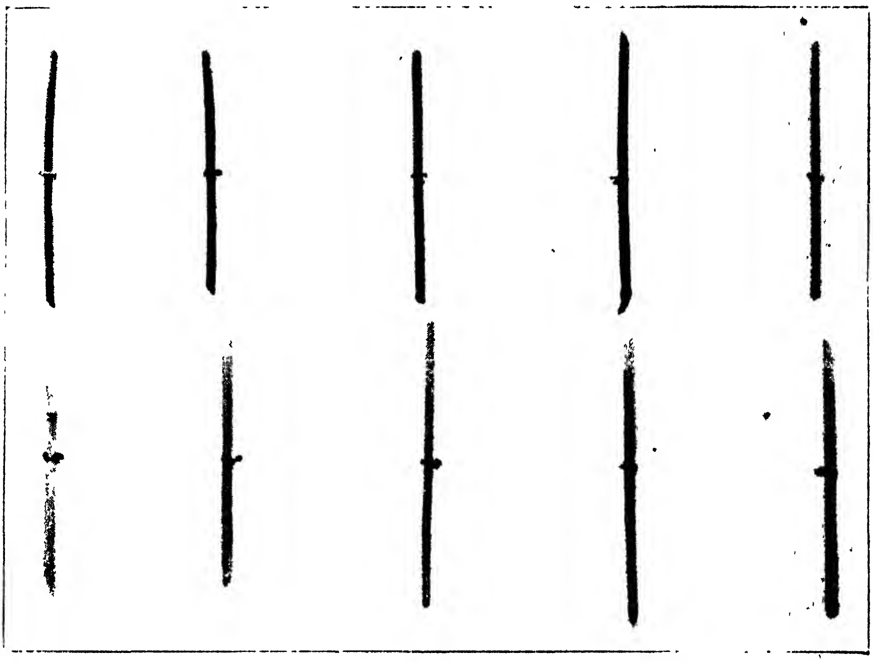

Fig. 9.
Segments of stalks of wheat at harvest time. Top: dark purplish grey discoloration from plots not receiving copper. Bottom: light golden straw from plots receiving copper.

Photo. Government Printer.

(4) *Discussion.*

It will be observed from the harvest returns in Table 4 and in Fig. 6 and also in Tables A and B of the Appendix that the use of copper either with or without zinc and manganese caused improvement in yield of grain over the whole of the plots, and eliminated unevenness due to soil variations and the development of white and empty heads on the gravelly soils. The quadrats show that with copper on these poor gravelly soils, the yield of wheat grain is very good and at least equal to that on other soil types of higher fertility. Without copper, the yield of grain is very low and in accordance with previous experience.

There is a slight suggestion that ferrous sulphate and manganese sulphate may have been beneficial, especially on the poor gravelly soils of the south-east portion of the area.

TABLE 4.

Average yields of wheat at Wagin, computed from duplicate plots harvested and from 10 quadrats from each treatment:—

Treatment.	Yield of Wheat. Harvester.	Yield of Wheat. Quadrats.
	Bushels per acre.	Bushels per acre.
Superphosphate—1 cwt. per acre	17·5	17·2
Control (superphosphate—1 cwt. per acre, sulphate of potash—½ cwt. per acre)	20·5	19·1
Control plus 20 lbs. manganese sulphate	22·3	22·0
Control plus 20 lbs. ferrous sulphate	22·0	21·5
Control plus 20 lbs. copper sulphate	25·6	27·0
Control plus 10 lbs. zinc sulphate	19·8	19·4
Control plus 10 lbs. borax	17·4	18·1
Control plus 1 lb. cobalt chloride	20·6	21·0
Control plus 20 lbs. manganese sulphate, 20 lbs. copper sulphate, 10 lbs. zinc sulphate	22·2	28·9
Plots receiving copper (4)	23·9	28·0
Plots without copper (20)	20·1	19·6
Standard error of the mean difference between plots receiving copper and those without copper	± 1·80	± 1·06

TABLE A.

(Appendix.)

Yield of grain from the experimental plots at Wagin, estimated in bushels per acre from square yard quadrats:—

Plot No.	Treatment.	Row A. Bushels per acre.	Row B. Bushels per acre.	Row C. Bushels per acre.	Row D. Bushels per acre.	Row E. Bushels per acre.	Average. Bushels per acre.
1	Super only	5·8	19·9	2·6	27·0	29·4	16·9
2	Control—Super + potash ...	11·7	12·5	34·9	30·5	30·7	24·1
3	Control + manganese ...	19·8	12·5	22·7	37·0	25·9	23·6
4	Control + iron	16·7	12·2	28·3	36·6	31·0	25·0
5	Control	16·2	11·1	23·3	32·1	8·3	18·2
6	Control + copper	40·6	15·7	33·0	28·4	26·4	28·8
7	Control + zinc	18·7	11·9	32·3	21·7	20·3	21·0
8	Control	14·6	18·5	33·3	13·4	24·2	20·8
9	Control + cobalt	22·3	29·6	37·4	15·4	13·3	23·6
10	Control + boron	22·5	29·6	24·1	8·3	7·5	18·4
11	Control	16·8	25·4	27·1	16·4	7·6	18·7
12	Control + copper, manganese, zinc	27·1	26·2	34·4	30·1	27·6	29·1
13	Super only	22·5	42·4	10·2	11·8	1·3	17·6
14	Control	21·9	21·3	21·5	24·6	0·8	18·0
15	Control + manganese ...	21·6	28·0	24·9	20·0	7·2	20·3
16	Control + iron	16·0	27·9	23·2	13·4	9·5	18·0
17	Control	17·5	23·8	30·1	14·1	1·2	17·3
18	Control + copper	24·8	28·2	26·1	22·1	25·1	25·3
19	Control + zinc	20·9	30·1	15·3	19·3	2·8	17·7
20	Control	28·8	27·2	12·7	17·1	0·2	17·2
21	Control + cobalt	29·4	33·3	12·7	14·4	2·2	18·4
22	Control + boron	26·0	22·6	22·1	11·3	7·2	17·8
23	Control	36·6	24·1	17·6	10·8	3·9	18·6
24	Control + copper, manganese, zinc	39·0	29·9	14·2	20·6	39·7	28·7

TABE B.

(Appendix.)

Yield of total air dry material from the experimental plots at Wagin, 1938, *estimated in cwts. per acre from square yard quadrats:—*

Plot No.	Treatment.	Row A. Cwts. per acre.	Row B. Cwts. per acre.	Row C. Cwts. per acre.	Row D. Cwts. per acre.	Row E. Cwts. per acre.	Average. Cwts. per acre.
1	Super only	21·6	27·0	13·4	43·2	43·2	* 29·7
2	Control—super + potash ...	27·0	24·3	51·2	43·2	45·9	38·3
3	Control + manganese ...	29·7	19·0	37·8	59·3	43·2	37·8
4	Control + iron	24·3	19·0	43·2	54·0	43·2	36·7
5	Control	27·0	27·0	32·4	48·5	21·6	31·3
6	Control + copper	64·8	29·7	51·2	45·9	40·5	46·4
7	Control + zinc	29·7	27·0	48·5	32·4	37·8	35·1
8	Control	27·0	29·7	54·8	24·3	37·8	34·7
9	Control + cobalt	37·8	40·5	62·1	24·3	29·7	38·9
10	Control + boron	35·1	45·9	48·5	16·2	24·3	34·0
11	Control	29·7	37·8	48·5	26·9	24·3	33·4
12	Control + copper, manganese, zinc	40·5	43·2	56·6	43·2	35·1	43·7
13	Super only	32·4	62·1	21·6	26·9	13·4	31·3
14	Control	37·8	54·0	37·8	37·8	16·2	36·7
15	Control + manganese ...	37·8	45·9	43·2	35·1	24·3	37·3
16	Control + iron	35·1	43·2	45·9	21·6	29·7	35·1
17	Control	35·1	37·8	51·2	26·9	21·6	34·5
18	Control + copper	40·5	43 2	40·5	32·4	37·8	38·9
19	Control + zinc	32·4	45·9	32·4	32·4	18·8	32·4
20	Control	43·2	43·2	32·4	26·9	24·3	34·0
21	Control + cobalt	45·9	54·0	32·4	24·3	21·6	35·6
22	Control + boron	43·2	43·2	32·4	21·6	24·3	32·9
23	Control	56·6	37·8	35·1	29·7	32·4	38·3
24	Control + copper, manganese, zinc	64·9	43·2	26·9	32·4	56·6	44·8

(5) *Conclusions.*

(1) The use of copper sulphate has proved beneficial to the growth of wheat on some light lands in the Wagin district.

(2) On the poorest soil type (a gravelly sand) wheat failed to mature grain with superphosphate and sulphate of potash but produced a good crop when copper sulphate was used as an additional manure.

(3) Copper sulphate improved the apparent health and vigour of the wheat throughout the growing period.

(4) Other "minor" elements failed to produce substantial increases in yield on any soil type. Manganese and iron salts may have effected small increases on the poorest soil types.

(5) Borax and zinc sulphate interfered somewhat with germination.

(6) There is every indication that the poorer gravelly, sandy soils will give a payable response to small dressings with copper where previous crops of wheat, oats or barley have been unsatisfactory. Responses are less likely where a loamy subsoil occurs at a shallow depth.

(7) There is every likelihood that benefits from copper will be shown in improved quality of pasture and in the health of animals grazing on such types of country if they are unable to have frequent access to the better soil types.

The symptoms observed in the course of this experiment will enable diagnoses to be made elsewhere and offer an interpretation of previous crop failures on certain soil types. Experiments are being planned to ascertain more accurately the response to copper in relation to soil type, the most economical dressing to be used and the lasting value of the treatment.

IV.—THE EFFECT OF "MINOR" ELEMENTS ON THE GROWTH OF WHEAT IN OTHER PARTS OF THE STATE.

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A number of experiments with other elements, in addition to superphosphate, have been carried out at several centres in the wheat belt. Sites were selected on account of unsatisfactory growth of wheat or interest in special soil characters.

(a) *In the North-Eastern Wheat Belt—Cleary.*

The patchy growth of wheat on certain brownish and pinkish brown soils of the north-eastern wheat belt had been observed for a number of years but no soil factor such as texture, profile, reaction or salinity could be correlated with the condition. In order to test the effect of minor elements under these conditions experiments were arranged in 1937 on Mr. B. B. Cooper's (two sites) and Mr. J. Blakeborough's properties north of Cleary.

The soils of the experimental areas on Mr. Cooper's property (Ninghan loc. 2972) were—(a) pinkish brown sands to loamy sands which carried cypress-pine (*Callitris glauca*), mallees, acacia scrub and scattered salmon gums in the virgin state, and (b) red brown to brown sands which, in the virgin state, had carried acacia scrub with a sprinkling of mallee and cypress-pine. On Mr. Blakeborough's property (Ninghan loc. 2935) the soils were a pinkish brown loamy sand showing some clay accumulation with depth. The virgin timber was cypress-pine with scattered mallees and interspersed with patches of acacia scrub.

On both properties the exploratory experiments, involving the following fertiliser treatments were laid down by Mr. W. M. Nunn, the Agricultural Adviser of the district. The plots were each 695 links long by 14.4 links wide (one-tenth of an acre in area) and each treatment was duplicated.

The fertiliser treatments detailed in Table 5 were used.

None of the treatments had any marked effect on the growth. Marked deepening of the green colour of the foliage was noted in early stages where the mixture of minor elements was applied and there was some impairment of germination. In October, inspection revealed no observable differences in amount or habit of growth on any plots.

Unfortunately, yields were obtained only from Mr. Blakeborough's plots and are reported in Table 5. Similar results were expected from the plots on Mr. Cooper's farm.

The possible deleterious effect of certain constituents of the "minor" element mixture may have been responsible for the lack of positive results and further trials with individual salts at lower rates seem justified.

TABLE 5.

Yield of wheat under various fertiliser treatments on Mr. J. Blakeborough's farm. Cleary. Sown on fallow, May 21st, 1937, using Totadgin wheat at the rate of 45 lbs. per acre:—

Treatment.	Yield Per acre.		Yield Per cent. of Control.
	Bus.	lbs.	
Superphosphate—1 cwt. per acre	10	52	100
Superphosphate—1 cwt. per acre ... ... Sulphate of ammonia—1 cwt. per acre	10	55	100
Superphosphate—1 cwt. per acre ... ... Sulphate of ammonia—1 cwt. per acre ... ... Sulphate of potash—½ cwt. per acre	9	28	87
Superphosphate—1 cwt. per acre ... ... Sulphate of ammonia—1 cwt. per acre ... ... Sulphate of potash—½ cwt. per acre .. .. Borax, sulphate of copper, zinc sulphate, magnesium sulphate, manganese sulphate, each 20 lbs. per acre	9	25	87

(b) *Salmon Gums Research Station.*

The unsatisfactory growth of wheat and oats on the Beete calcareous sandy loam or "kopi" is not correlated with known factors in all cases. Salinity often causes poor growth but many patches of non-saline areas of this type fail to mature a crop of cereal. Over a number of years it has been shown that stable manure, applied at the rate of 15 tons per acre with the biennial cropping programme, gives quite satisfactory yields, but manganese sulphate (56 lbs. per acre) failed to produce any beneficial effect. Likewise various "minor" elements applied to this soil type in 1938 failed to effect improvement of growth or yield of wheat.

Yields obtained from these experiments are given in Tables 6 and 7.

TABLE 6.

Effect of stable manure at the rate of 15 tons per acre with each crop and manganese sulphate at the rate of 56 lbs. per acre on the Beete calcareous sandy loam (kopi) on the Salmon Gums Research Station:—

Year.	Treatments (weights per acre). Superphosphate—1 cwt.		Superphosphate—1 cwt. Stable manure—15 tons.		Superphosphate—1 cwt. Manganese sulphate—56 lbs.	
	bus.	lbs.	bus.	lbs.	bus.	lbs.
1932	6	56	9	36	6	8
1933	7	1	9	36	7	33
1934	5	36	12	16	5	52
1935	4	32	9	12	4	45
1936	4	19	10	21	5	9
1937	5	39	11	49	...	...
1938*	19	25	26	40	...	...

* Exceptionally wet year at Salmon Gums.

TABLE 7.

Yield of wheat on Beete calcareous sandy loam (kopi) on the Salmon Gums Research Station under various fertiliser treatments. Planted May 30th, 1938, with Gluyas Early wheat, sown at the rate of 45 lbs. per acre. All minor elements applied as salts at the rate of 20 lbs. per acre mixed with the superphosphate.

Treatment.	Yield of Wheat		
	Per acre.		Per cent. of Control.
	bus.	lbs.	
Superphosphate—1 cwt per acre	16	56	100
Superphosphate plus manganese sulphate	13	40	81
Superphosphate plus ferrous sulphate	14	40	87
Superphosphate plus zinc sulphate	17	16	102
Superphosphate plus copper sulphate	17	12	101
Superphosphate plus magnesium sulphate	16	12	96

It is possible that the calcareous nature of this soil interferes with the availability of essential minerals applied as fertilisers in the usual way. Spraying experiments are planned this year to test the effect of foliage treatment.

(c) *Wongan Hills Research Station.*

The Wongan Hills Research Station is used to study methods of developing good class sandplain country in the better rainfall areas of the wheat belt. In the drier years very creditable crops of wheat and oats are produced with the aid of superphosphate applied at the rate of about 120 lbs. per acre. Without superphosphate cereals will make no growth beyond that permitted by the reserves in the seed. With superphosphate the growth of cereals is apparently normal. No symptoms of malnutrition has been observed, except on gravelly bars.

The effect of other elements on the growth of wheat on the better soil types of the Research Station was explored in an experiment involving three series of 6 x 6 latin squares in 1938.

The surface soil at the site of the experiments consisted of a greyish yellow sand (pH 6.7) resting on a yellowish subsoil of sandy loam texture. Below 20 inches depth a little ferruginous gravel and red mottlings were observed and the pH was slightly lower. This soil type would be of considerably higher fertility than the gravelly sand, on which marked response to copper was obtained at Wagin (see Paper III, page 135).

Nabawa wheat was sown by hand and the fertilisers applied to the same rows. The fertilisers were applied as complete mixtures for each plots and, to ensure uniform application, the appropriate quantity for each row weighed into an envelope prior to sowing.

The plots sown were each 48 inches long by 7 rows wide (49 inches) and one square yard from the centre was harvested for yield computation.

During the growing season little reaction to the treatments was observed but borax appeared to interfere somewhat with germination.

Harvest returns are summarised in Table 8.

The results indicate that the "complete"† fertiliser at the rate of 1 cwt. of sulphate of ammonia, 2 cwts. of superphosphate and ½ cwt. of sulphate of potash per acre is not significantly superior to superphosphate alone.

† Containing nitrogen, phosphorus, and potassium.

TABLE 8.

Yield of Nabawa wheat resulting from treatments with "minor" elements at the Wongan Hills Research Station. Sown May 18 and 19, 1938. Harvested December 1, 1938. Control mixture: *Sulphate of Ammonia—1 cwt. per acre; superphosphate—2 cwts. per acre; sulphate of potash—½ cwt. per acre.* "Minor" elements: *Manganese sulphate, copper sulphate, zinc sulphate, ferrous sulphate and magnesium sulphate—each 20 lbs. per acre. Borax—10 lbs. per acre.*

Treatment.	Yield of Grain — Per acre.	Yield of Grain — Per cent. of Control.
Series I.—	bus.	
Control—N + P + K	33·9	100
Control plus copper sulphate	30·1	89
Control plus manganese sulphate	34·0	100
Control plus borax	25·9	76
Control plus zinc sulphate	18·9	56
Control plus magnesium sulphate	31·0	91
Difference necessary for significance (P = 0·05) = ± 5·8 bushels per acre.		
Series II.—		
Control—N + P + K	27·8	100
Control plus ferrous sulphate	27·0	97
Control plus manganese sulphate, copper sulphate	21·4	77
Control plus manganese sulphate, copper sulphate, zinc sulphate	19·2	69
Control plus manganese, copper, zinc, magnesium and ferrous sulphates and borax	18·0	65
Control plus Mixture*	18·0	65
Difference necessary for significance (P = 0·05) = ± 4·7 bushels per acre.		
Series III.—		
Control—N + P + K	31·4	100
Superphosphate only—2 cwts. per acre	26·4	84
Superphosphate plus borax	18·2	58
Superphosphate plus manganese sulphate	23·6	75
Superphosphate plus zinc sulphate	11·1	35
Superphosphate plus copper sulphate	21·0	67
Difference necessary for significance (P = 0·05) = ± 5·8 bushels per acre.		

* Mixture contains sodium tungstate, cobalt chloride, antimony chloride, potassium iodide and nickel chloride each at the rate of 5 lbs. per acre.

None of the "minor" elements showed to advantage. Manganese sulphate, copper sulphate, ferrous sulphate and magnesium sulphate at the rate of 20 lbs. per acre, in addition to the "complete" fertiliser, did not significantly affect the yields. Zinc sulphate and borax each at the rate of 10 lbs. per acre proved harmful, as did all of the mixtures of "minor" elements.

The most outstanding result was the deleterious effect of zinc sulphate at the rate of 20 lbs. per acre. (Millikan (1938) in Victoria has reported improved yields from similar dressings in the Wimmera.) When used alone or mixed with other minor elements, zinc sulphate reduced the yield substantially, caused considerable to very severe shrivelling of the grain and induced a dirty, greyish colour on most of the injured grain.

Apparently zinc salts need to be handled with care and used in small applications with wheat on light soils. Reports of damage to potatoes have been received from Albany.

The mixture containing tungsten, cobalt, antimony, iodine and nickel also proved deleterious. The grain was shrivelled but no discoloration was observed.

It is obvious from these results that the use of minor elements for wheat cannot be expected to give improved returns except on certain soil types and under certain conditions. The observation of the crop symptoms—reaction to drought, tipping of the leaves, firmness of the rooting system, appearance of the head and discoloration of the sheaths, glumes, etc.—will give indications of possible deficiency of minor elements for cereals and will point to the need for experimentation. Where crops are healthy and vigorous, response in crop growth to minor elements is not to be expected.

(d) *Conclusions.*

1. The use of "minor" elements for the growth of wheat on soil types at Cleary, Salmon Gums and Wongan Hills failed to improve the yield.

2. Significant depression in yields resulted from the use of zinc sulphate, borax, and various mixtures of "minor" elements on the acidic sandy soils of Wongan Hills. Zinc sulphate was especially injurious.

3. At Cleary, a "minor" element mixture interfered with germination and yield of wheat but in the early growth stages caused the development of a deeper green colour than in the controls.

4. On the Beete calcareous sandy loam (kopi) at Salmon Gums stable manure gave substantial increases in the yield of wheat but no "minor" elements were effective.

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SHEEP RUGGING EXPERIMENT.

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INTRODUCTION.

During recent years the question of rugging flock sheep has been a subject of considerable interest throughout Australia. It has been claimed by many agriculturists and farmers, particularly in South Australia, that rugging improved the value of the wool by preventing the entrance of dust and dirt which interfered with the free distribution of the yolk, thus causing the drying out of the tip of the wool, making it dry, harsh, and lacking in character. Further, in districts where plants having burry seeds like Burr Trefoil were prevalent, the rugs had the added advantage of preventing such seed pods from becoming attached to the wool and so further reducing its value. It was further stated that the increased value per lb. in the wool was more than sufficient to pay for the cost of rugging, and so was an economical proposition.

In view of the statements made and the absence of any particular experimental data in this State, it was decided in 1936 to institute experiments at three of the Research Stations in the Wheat Belt to obtain definite information on the question.

The idea of rugging flock sheep apparently originated in South Australia. In 1935 Scott (1) drew attention to the results of experiments conducted at the Turretfield Experiment Farm in 1934. It appears that these experiments were conducted under dusty conditions as Scott stated that the dirt had fouled the wool on the back down to the skin and had destroyed the character of the wool, making it harsh, trashy and without life. It was stated that the increase in wool values due to rugging amounted to 2s. per head. Since then, other reports on recent investigations on the subject have been published. In experiments conducted by Montgomery (2) at Albury, N.S.W., heavy burr and dust contamination were avoided. He concluded that rugging was very unlikely to be economical under conditions of low rainfall and moderate temperatures, in the absence of burr and dust. Further experimental work was necessary to show what economical returns would be obtained where heavy contamination with dust or burr was encountered. The experiments of Blumer and Cotsell (3) were carried out under winter conditions, the experimental sheep being rugged in May, having been shorn the previous October. The authors concluded that rugging had no commercial value in the five winter months in New England (N.S.W.) but pointed out that the results did not apply to any benefits which might result under burry and dusty conditions. The experiments conducted at Condobolin (N.S.W.), reported by Elliott (4), although somewhat limited, indicated that there was a difference of approximately 50 per cent. in the per lb. value of the fleece wool from the rugged sheep. When, however, the difference in the average fleece weight was considered (7.75 to 9.93 lbs.) there was only an average increase of 2½d. in favour of the rugged sheep. Apparently conditions were very dusty in these experiments. Peirce (5), reporting on experiments at the Waite Institute (S.A.), stated that rugging had no effect on the milk production of the ewe or upon the early growth of the lamb.

DETAILS OF W.A. EXPERIMENTS, 1936-1938.

After dipping in 1936 at the Chapman, Salmon Gums and Yilgarn Research Stations, twenty plain-bodied four-tooth Merino ewes were selected and divided into two groups, by drafting off alternate sheep. One group was rugged with a light duck rug of local manufacture, costing 15s. a dozen, and the other group was not rugged. Each sheep carried an individually numbered ear tag. Both groups were

run together with the main flock, which was kept under the ordinary flock conditions at the Research Stations, which must be considered typical of the farming areas of Western Australia, and included grazing on fallowed land at various periods. Such conditions are somewhat dusty at times, and do produce a dry dusty tip in the wool. Severe dust storms, however, are not general in these areas. There is very little burr trefoil at either Yilgarn or Salmon Gums, and is only present in the wool at Chapman in years of heavy rainfall. During the summer months when feed was scarce, considerable trouble was experienced owing to the rugs being damaged by the bush and scrub, and it was necessary from time to time to yard the sheep to adjust and repair the rugs. Towards the end of May, *i.e.*, at the commencement of the winter, the rugs were removed, as it was not considered necessary to keep them on after the seasonal winter rains commenced. When the rugs were removed the wool of the rugged groups at all stations looked much cleaner, heavier in condition and brighter in appearance, and at Yilgarn an improvement in both the condition of the wool and the sheep could be noticed. The month of July, however, was an unusually dry one and dusty conditions were prevalent so that at shearing time little or no difference could be detected between the two groups at any station. No deaths occurred and none of the experimental sheep were fly-struck, while there was no significant difference regarding the incidence of lambing in either group. From Table I. it will be seen that there was no significant difference in the average wool yield per head.

TABLE I.

Station.	Date Rugged.	Date Rugs Removed.	No. of Days Rugged.	Average Yield of Wool per Head.	
				Rugged.	Not Rugged.
	1936.	1937.		lbs.	lbs.
Chapman	Nov. 3	May 17	195	9·0	10·0
Salmon Gums	Dec. 19	May 27	159	12·2	12·1
Yilgarn	Oct. 15	May 28	225	9·5	10·1

The wool from each group was classed and forwarded to Messrs. Elder, Smith & Co.'s Wool Store, Fremantle, where it was valued by the manager of the Wool Department (Mr. K. Hodge). He reported that there was practically no difference in regard to the presence of dust or in the density of the two groups from Yilgarn, and valued the rugged wool at ½d. to ¾d. per lb. (approximately 4 per cent.) more than the unrugged wool. The unrugged wool from Chapman looked better grown, longer in staple and more robust and drier, and was valued at 1d. to 1½d. per lb. (approximately 8 per cent.) more than the rugged wool. The wool from Salmon Gums exhibited little or no difference in tip, in regard to amount of dust, appearance or value, and on the wool floors, both lines would have been lotted together. The rugged wool was slightly denser, more robust and heavier in condition, but there was slightly more money, amounting to ½d. per lb. in the unrugged wool, as the skirtings were slightly drier.

It must be admitted that the conclusions which can be drawn from this, the first year's experiment, must be limited but they indicate that under the conditions prevailing at these Stations, rugging did not increase the value of the wool return. Owing to the limitations of the 1936-37 experiments, it was decided to continue the investigation, enlarging each group to 50 sheep, using improved and better quality rugs and keeping the rugged section rugged from dipping time to the following shearing, *i.e.*, approximately eight to nine months.

The Yilgarn sheep comprised 100 even type full sound mouth merino ewes, which were drafted off alternately into two groups of 50 each. The Chapman sheep comprised 34 four-tooth, 30 six-tooth and 36 full but sound mouth merino ewes which, after mixing, were divided into two lots by alternate drafting. The Salmon Gums sheep comprised 35 two-tooth, 5 four-tooth, and 10 six-tooth merino ewes in each group. After rugging and ear tagging, the experimental sheep were run with the main farm flock as in the previous year.

At both Chapman and Yilgarn considerable trouble was again experienced through the rugs becoming damaged and torn by the scrub. Sheep which were found without rugs were excluded from the experiment, and wherever possible torn rugs were repaired. Where necessary very badly torn rugs were replaced by new ones. During the course of the experiment the total number of rugs used for the 50 experimental sheep at the respective stations was, Salmon Gums, 53, Yilgarn 80, and Chapman 88. The number of sheep excluded on account of loss of rugs was four, viz., one at Chapman and three at Salmon Gums. The number of deaths recorded was twelve, the numbers in the rugged and unrugged groups being respectively, Chapman nil, 1; Salmon Gums 1, nil; and Yilgarn 4, 6.

Blowflies were more prevalent in this experiment. At Chapman four of the rugged group and five of the unrugged group were struck, whilst at Yilgarn the respective figures were two and nil and Salmon Gums 13 and 11. Those struck at Yilgarn were excluded from the experiment as it was necessary to remove the rugs.

At Chapman 94 per cent. of the rugged and 92 per cent. of the unrugged ewes produced lambs and at Salmon Gums the respective figures were 60 per cent. and 70 per cent., the smaller number of lambs being accounted for by the number of maiden ewes in the groups. At Yilgarn when the ewes were crutched it was recorded that most of them were in lamb. Later, owing to the adverse season, the sheep were yarded as little as possible, and hence a detailed record of the individual lambing was not possible. It is concluded that rugging did not interfere with the mating or fertility of the ewes or cause any difficulty at lambing.

After shearing, the wool was carefully classed into its appropriate classes, each group and class being kept separate. As before, it was forwarded to Elder, Smith & Co.'s Fremantle Store and each class valued individually by Mr. K. Hodge (Manager, Wool Department). The wool yield and values per head are shown in Table II.

TABLE II.

Station.	Date Rugged.	Date Shorn.	Days Rugged.	Rugged.				Not Rugged.			
				No of Sheep.	Total Wool Yield.	Average Wool Yield per head.	Value of Wool per head.	No of Sheep.	Total Wool Yield.	Average Wool Yield per head.	Value of Wool per head
	1937.	1938.			lbs.	lbs.	s. d.		lbs.	lbs.	s. d.
Chapman	Dec. 14	Aug. 23	253	49	443	9·04	7 6	49	481	9·82	7 11
Yilgarn	Dec. 10	Sept. 6	271	44	370	8·41	6 5	44	366	8·32	5 9
Salmon Gums	Dec. 9	Sept. 21	287	46	430	9·35	8 10	50	478	9·56	8 11

Such small differences are most unlikely to be significant, but even in the case of Yilgarn, an apparent improvement of 8d. per head would not be an economic proposition when the cost of the rugs and the time employed in adjusting and repairing them is taken into consideration.

It is desired to acknowledge especially the assistance rendered by Mr. K. Hodge, manager of the Wool Department of Messrs. Elder, Smith & Co., who valued the wool from the experimental sheep and Messrs. F. Gishubl, J. H. Moulton and W. Human, Managers of the Chapman, Salmon Gums and Yilgarn Research Stations respectively, who carried out the field details of the experiments.

SUMMARY.

A brief review of the literature regarding the rugging of sheep is given.

Experiments conducted at the Chapman, Yilgarn and Salmon Gums Research Stations from 1936 to 1938 are described. It is concluded that (1) the rugging of flock sheep in the farming areas of Western Australia will not increase the value of the wool clip, and is therefore not warranted; (2) rugging, however, did not interfere with the mating or fertility of the ewes, nor cause any difficulties at lambing time.

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FIRST EARLY SUBTERRANEAN CLOVER.

NOTES ON ESTABLISHMENT.*

H. G. ELLIOTT, Agrostologist; T. C. DUNNE, Agricultural Adviser.

No more suitable pasture species for the areas having a rainfall of 16-25 inches per annum has been yet found than First Early ("Dwalganup") subterranean clover. The plant meets many requirements in that not only has it been successful for grazing but it allows hay and silage of excellent quality to be conserved. This is of great importance in providing for sheep a summer feed which is not only a concentrate but which is relatively inexpensive. The large amount of seed formed underground in burrs forms another nutritious food reserve. Under favourable conditions, even when a hay crop has been taken off, some hundreds of pounds of seeds per acre may be found under an established sward. The burrs containing the seed can easily be brought to the surface with a cultivator or scarifier, when they will be readily eaten by sheep. The clover is further recommended by virtue of its value as a soil renovator and its inclusion as a unit in crop rotation in the areas mentioned will undoubtedly result in the production of better cereal crops. Its utilisation for this purpose has already been recommended (2).

During the last five years there has been a rapid expansion of the growing of the first early variety of subterranean clover in the 16 in. to 25 in. rainfall area and it is confidently expected that there will be a further large increase in the areas sown to this clover for sheep farming. A publication dealing with subterranean clover generally is already available (1) but for those without previous experience with the early strain some directions for establishment are given.

Seed and Strain.

In procuring seed for areas under review, only certified First Early ("Dwalganup") subterranean clover should be considered. This is the earliest flowering strain at present available and the only one with which success can be assured with a rainfall of less than 25 inches per annum. Many farmers in previous years have made efforts to introduce subterranean clover but their attempts have been nullified by the wrong strain of seed having been sown. At Muresk this early strain flowers about the second week in August and seed is formed while the soil is still moist enough for the burrs to be buried. For maintenance and improvement of the pasture it is essential that the clover be able to bury the seed.

So important has the question of securing the correct strain become that in 1935 the Department of Agriculture introduced a system of certification for the First Early ("Dwalganup") strain of subterranean clover and prospective buyers should insist on obtaining certified seed. During the last few years many other strains of early subterranean clover have been located, the most important of these being Mulwala, Nangeela and the Cookernup white seeded. Trials are being conducted at present with these.

Where to Sow.

One of the advantages of subterranean clover lies in its ability to thrive on soils which have been depleted of fertility by cropping. Not only does it thrive under these conditions but it renews the fertility of such areas. When selecting areas for sowing it is best to begin on paddocks which show the need of an extended period of rest before reverting to cereal cropping. Less competition from other plant species will be experienced and a good sward of clover will soon be established.

The clover does well on a variety of soils. Particularly satisfactory results are secured on light sandy soils which are often not productive with other crops. Excellent results are also secured on heavier soils, particularly where the rainfall is good. Where the rainfall is lower, *i.e.*, approximating 16 inches per annum, it will probably be best to begin on the lighter soils as there is a possibility of the surface of the heavier soil becoming hard before the seed can be buried. On the other hand, it may be possible to obtain good results on sandy soils with an annual rainfall of less than 16 inches. During the last two seasons promising results have been observed in the 12 in. to 16in. rainfall belt on sand-plain country.

Time of Sowing.

This seed should not be sown early in dry soil as there is danger of germination with a light shower and subsequent dying of the young seedlings should a dry spell follow. It is necessary to await the arrival of the reliable winter rains which normally occur early in May. This will allow plenty of time for satisfactory first year growth and seed formation.

Cover Crop.

Subterranean clover may be established successfully with or without a cover crop. Sowing with a cover crop such as oats, which has been used for grazing off or to be harvested for hay or grain, has much to recommend it, in that the clover is only very little grazed in the case where the feeding off of the cover crop occurs, and is protected from grazing where it is to be left for hay or grain, with the result that the clover will multiply considerably during the first year, without loss of time.

* Revised from the article of the same name by T. C. Dunne, published in this Journal for March, 1935, pages 81-84, and which was subsequently issued as Leaflet No. 442.

Another advantage of sowing with a cover crop is that in most cases a reasonable seed bed is prepared prior to sowing, and that a considerable amount of fodder is produced during the first year of establishment.

The use of a cover crop, however, depends to a large degree on the rainfall of the area, and the type of soil on which it is intended to sow the seed. In the lower rainfall areas, with light sandy soils, a light cover crop can be used successfully. On the heavier types of soil, however, a cover crop is not recommended.

A seeding rate of 2 to 3 lbs. of clover seed per acre should be incorporated with the cover crop, or 4 to 5 lbs. per acre when clover only is sown. In the better rainfall areas cover crops can be used successfully, and a clover seed sowing as light as 1 lb. per acre may sometimes be sufficient to introduce the plants where a cover crop is used, but it takes somewhat longer for the clover to spread and completely cover the ground. It must be emphasised that an excellent germination alone, with the correct method of sowing must be utilised for this light rate of seeding to give satisfactory results. Where no cover crop is used, it is advisable to sow 4 to 5 lbs. of seed in order to obtain a certain amount of feed in the first year.

Rate of Seeding.

Seed production by this clover is so prolific, that it is often found more economical to sow the seed lightly, and let it multiply in the field than to sow heavily enough for a complete cover in the first year. Where seed can be obtained cheaply, or is cleaned on the farm, rates as high as 8 lbs. per acre have been used with success. Experiments have shown, however, that 4 lbs. per acre is about the maximum for economical establishment.

As stated under the section of cover crop, varying rates of seeding can be utilised, and where the cover crop is used, 2 to 3 lbs. per acre of clover seed is quite satisfactory. If a cover crop is not used. 4 to 5 lbs. of seed per acre is recommended.

By nature, subterranean clover has a fairly high percentage of hard seeds, *i.e.*, seeds which do not germinate during the first season but will germinate in later years. In the process of extracting the seed from the burrs, however, most of the seed is scratched and the percentage germination is considerably increased.

While it is not advisable to buy clover burr for fear of introducing insect and plant pests, it is a good practice to collect burr from any area on the farm already under subterranean clover and thus to sow other areas. The percentage germination of this unscratched seed would be fairly low and a heavier seeding would be necessary. At least enough burr to give about 8 lbs. of seed per acre should be distributed. Good clean burr which is free from stems, stones and small sticks should give about one-quarter of its weight as clean seed. When raking for burr, the sample obtained may contain, if not cleaned, only about one-tenth of its weight as clean seed.

Methods of Seeding.

Results at Muresk (3) on lighter types of soils showed that with subterranean clover seed the best germinations were obtained with the seed sown at the ¼ in. and ½ in. depths. The germination at 1 in. was satisfactory but the number of plants from deeper plantings showed a considerable decrease and at 2 in. failure resulted. Apart from the germination, the time factor was important. The results showed that the seed planted at ¼ in. had practically given a complete seedling appearance in seven days, whereas it was 17 days before a reasonable number of plants appeared from the 1 in. sowings.

Covering of the subterranean clover seed with soil is essential. Results show that where the seed is dropped on the surface of cultivated soils a certain amount of covering is obtained, but it is probable that a large proportion of the seed obtains no covering with consequent poor establishment. The result is of more importance in relation to the establishment of clover on uncultivated paddocks. Actually almost total failures have been observed where clean seed was broadcast on the surface of bare uncultivated paddocks without any effort being made to give a light covering.

When a cover crop is used it is safest to make the sowing of the clover seed separate, either using a small seeds box attachment on the drill or "combine," broadcasting the seed by hand or through a broadcaster. The seed may be covered in the case where the small seed box attachment is used by tying the tubes from the box back so that a light covering is given by the rearmost tynes of the "combine." Alternatively, covering may be obtained by following with a light harrow and, where it is sown through a topdresser or drill, a chain dragged behind will usually give enough cover.

In order to spread the small amount of seed evenly it should be mixed with sand or, if this is not easily available, with superphosphate. If superphosphate is used, however, it should be mixed with the seed immediately before sowing, as if left in contact with the seed for any length of time it may have a detrimental effect on germination.

Satisfactory germination has been secured in some instances by mixing the seed with the superphosphate and sowing through the drill with the cover crop. Failures, however, have been recorded, presumably through the seed being buried too deeply. Broadcasting the seed separately or using the small seeds box attachment is recommended as being the safer method to adopt.

Where no cover crop is used, some effort to provide a light covering of soil for the seed as stated above will be well repaid by better germination. This is especially the case on lighter soils or where the soil is quite devoid of any material such as dead grass which would help the seedlings to take hold. A light harrowing should be given before sowing and covering provided as suggested above.

When clover burr is used, there does not appear to be the necessity for providing a covering of soil such as is required with clean seed. The burrs themselves tend to take hold of the soil particles and to become partly buried with the early rains. For this reason it is doubtful whether any cultivation given prior to sowing clover burr would be profitable.

Inoculation (4).

All plants belonging to the legume family, which includes clover, peas, beans, etc., have the ability to use atmospheric nitrogen for growth but only when the proper bacteria, which vary for different groups of plants, are present. The bacteria, which are present in the soil where cluster clover, hop clover and other common clovers (but excluding burr trefoil) are growing, are those needed by subterranean clover, and on such areas satisfactory results will be secured. In some cases, however, these clovers are not present and inoculation of the seed with the necessary bacteria is advisable. For this purpose bottles containing bacteria for inoculation, together with directions for use, are provided by the Department of Agriculture at a nominal cost.

Seed so inoculated should not be mixed with superphosphate prior to planting as the superphosphate injures the bacteria. The best practical methods of sowing are those in which the inoculated seed is sown at the same time as the superphosphate, but where no contact is made, as with the small seeds box attachment on a drill or "combine," or where the contact between the seed and fertiliser is only

momentary, as is the case when the seed is sown through the grain section of a drill or "combine." It is essential that the ground should be wet at the time of sowing.

Fertiliser.

Fertiliser, in the form of superphosphate, is essential to the success of subterranean clover. The superphosphate should be applied at the time of seeding and thereafter each autumn. When the pasture is established the best time for application is with the advent of the first reliable rains. However, a heavy cereal cropping programme often prevents much attention to pastures at this time so that it may be necessary in many cases to apply the superphosphate earlier in the season on the dry land.

Previously it was recommended to apply from 90-112 lbs. of superphosphate per acre. However, recent experiments have shown that not less than 112 lbs. of superphosphate per acre should be applied annually and in many cases further profitable results have been obtained from applications as high as 180 lbs. per acre.

Management.

The use of a cover crop almost obviates the need for careful management in the first year, especially if the crop is not grazed. By the time the crop is removed the clover has matured and the seeds for the following year's stand are buried. Allowing formation and burying of as much seed as possible in the first year is an important factor in successful establishment.

More care is needed where no cover crop is used. The paddocks should not be grazed until some lateral development of the young clover plants has taken place. Again, at the time of seeding, stock should be kept away until the seeds have been buried. Subterranean clover, when dry, provides good feed, and grazing at this stage can have no detrimental effect on the subsequent pasture.

General.

Prospective growers are warned against expecting too much from early subterranean clover in the first year. At the rate of seeding suggested, only a thin stand is produced and the plants are characterised by long runners and scanty foliage. At this stage it appears rather unattractive. It must be remembered, however, that this habit of growth enables the clover to spread and eventually cover the ground. A vigorous plant in the open may have a number of runners up to three feet in length radiating from the centre. Burrs containing three or four seeds may be formed about every three inches along the stems. Such a plant could easily produce over one hundred seeds for the thickening of the stand the following year. When the stand becomes thick, the plants are forced into more upright growth and a mat of leafy pasture is obtained in the second or third year.

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THE INVESTIGATION OF "FALLING DISEASE" OF CATTLE IN THE SOUTH-WEST.

By H. W. BENNETTS, Veterinary Pathologist, and H. T. B. HALL, Veterinary Officer.

Introduction.

A disease of cattle characterised by a localised distribution, seasonal occurrence and by sudden death without previous signs of illness, has been known for some years in the Busselton and Northcliffe districts.

It was first reported to the Department in 1929.

Preliminary investigations were carried out by Veterinary Officers A. F. Flood and E. F. Twaddle and their observations and records have been most helpful.

No systematic investigation, however, was possible until 1937, when one of us (H.T.B.H.), was stationed in the Busselton district as a field officer for the purpose of studying the disease. Following his resignation about the end of 1938, Veterinary Officer R. Harley took over the work in the field. During 1938, the Assistant Animal Nutrition Officer, A. B. Beck, commenced chemical work which will be reported in detail at a later date.

During the last two seasons the Agricultural Bank has greatly assisted the investigators, both by providing locations and animals for experimental work, and by the co-operation of their officials in the Busselton district.

The purpose of this article is to describe a disease, which does not appear to have been reported from outside the State, and to give some account of the results of the investigations up to the present time.

Distribution and Economic Importance.

The area affected is a belt of coastal country in the south-western corner of the State. On the west coast it extends from Wonnerup in the north to Forrest Grove in the south and inland for a distance of about 10 miles.

Almost without exception only occasional losses have been reported from the older settlements along the coastal fringe. The disease occurs predominantly further inland on country which is largely devoted to Group Settlement. There is a further occurrence in the Northcliffe groups adjacent to the south coast.

The disease constitutes a grave economic problem as the group settlers, dependent almost entirely on dairying for a living, are ill equipped to stand the loss of income and capital resulting from the death of a number of cows, generally those just coming into profit.

Type of Country Affected—Pasture.

In the Busselton district the predominant timber, in the affected area, is jarrah or marri (red-gum). The soil types vary considerably, losses having been investigated on heavy loam, gravelly soils and on grey sandy soils—in general there is a yellow clay subsoil. The affected country at Northcliffe is similar.

The group settlement holdings consist of about 150 acres, of which—at the present stage of development—approximately one-half has been cleared and carries improved pasture. The average herd consists of 20 milking cows.

The holdings were originally sown with subterranean clover. This initially did well and good stands still persist on some locations. Commonly, however, for reasons not yet fully understood, this clover has "stalled" and its place has been taken

by drooping flowered or "reverse" clover which grows luxuriantly throughout, particularly on wet locations. This natural change has been going on for some years and almost without exception falling disease has occurred only on locations which have "reverted" to drooping flowered clover. On affected holdings during the period of the year—notably in September and October—when the disease occurs, the pasture tends in the main to be a prolific growth of this clover associated with suckling clover. Grasses come into prominence later in the year and mortality ceases about the time when grass begins to predominate over the clover. The following are then observed:—Yorkshire fog, sweet vernal, silver grass, spear grass, rye grass, barley grass; capeweed, flatweed and sorrell are also common. On wetter portions lotus major, paspalum and kikuyu grow luxuriantly and pastures may be green throughout the summer months.

Pastures are top-dressed annually with superphosphate, usually about 1-2 cwt. per acre—without this dressing they revert to Yorkshire fog, hop clover and the aforementioned weeds.

Occurrence of the Disease.

The occurrence varies from year to year, both as regards areas affected and individual properties.

On some locations deaths have been reported annually for the past six or seven years. From 5-40 per cent. of the herd may succumb, generally within a few weeks of the first appearance of the disease. Most of the stock carried on the group settlement holdings have been bred in the district. In some cases affected animals have never been off the locations on which they were born; most of the cows, however, have been transferred at some time or other from one location to another in the same district. There is no evidence of the disease being brought on to a property with an animal transferred from an affected location.

Season.

The disease is definitely seasonal: mortalities may occur from July to December, but only occasional deaths are reported earlier than September or later than October.

Species, Sex, Age, Condition.

Cattle only are affected. No deaths of a similar nature have been reported in horses, pigs, or in the comparatively few sheep which are carried in the district.

Sex.—The occurrence of falling disease has been confirmed only in cows, although a number of sudden deaths in bulls have been reported.

Age.—The disease appears to be more common in aged cows, although animals of any age from 12 months upwards, may be affected.

Condition.—Agricultural Bank records of reported cases of the disease indicate that cows in calf or recently calved are most susceptible. Of 16 cows examined in 1937, however, three were in calf, four had just calved and six were milking cows not in calf (no breeding history in three cases). Affected animals are generally in fair condition.

Symptoms.

"Falling disease" or "sudden death" is most frequently observed when cows are being brought in to be milked, are standing in the bail, or are being driven out to paddock again. In some cases the cows have actually fallen on the milker. Deaths also occur when cows are at pasture but are not observed very often. A cow,

apparently in normal health, suddenly bellows, throws up its head and falls dead. Death frequently appears to be instantaneous. Sometimes the animal falls and struggles feebly on its side on the ground for a period varying from a few seconds to five minutes. In these cases of longer duration intermittent bellowing, running movement of the legs and attempts to regain an erect posture are also noticed. Finally the animal lies stretched out with head back and dies.

The following is a settler's account of a death witnessed by him:—

> When I first started bringing the cows home she was perfectly normal and grazing with the rest. I had got them about half way home when she stopped and started swaying on her feet, she seemed to be paralysed and could not move, she also seemed to be forcing water from herself. She then started to stagger with her head down, as if she was drunk, after that she fell flat on her side and rolled completely over with her back downhill, her legs and neck stretched out straight and her legs quivering. She gave a few groans, her back legs doubled up and she turned partly over on her back, her legs then went straight again and she was dead. She died within one minute and a half of when she started to sway.

Rarely an animal may show symptoms for 24 hours or more, intermittently pivoting with the head down, before dying suddenly in the typical manner. Three such cases were observed by H.T.B.H.

Post Mortem Appearances.

The post mortem examinations of 25 typical cases by H.T.B.H. showed the following as the most constant and striking features:—The rectum and vagina are protruded somewhat, even immediately after death and are injected with blood. The carcase "blows up" very quickly. Internally the tissues are injected with blood, the liver is large and friable and the spleen large, dark and pulpy. The lining of the fourth stomach and small bowel is dark (congested). The appearances are not very characteristic. Microscopic examination of organs, however, shows definite and typical changes which enable one to say definitely that a cow has died of falling disease—the kidney changes are characteristic and the spleen and, to a less extent, liver and kidneys show extensive deposits of iron (hemosiderin).

Experimental Investigations.

In addition to the examination of affected animals referred to above, an extensive series of experiments has been carried out with a view to determining the cause of the disease. It is proposed to summarise them only briefly here.

Attempts were made to reproduce the disease by inoculating experimental cattle with blood from affected animals and by drenching them with stomach and bowel contents from falling disease cases. The results were negative.

A careful search was made for any bacteria which might be causing the condition—again the result was negative. It did not appear, therefore, that any germ or other infectious agent was responsible.

Surveys made by the Government Botanist (C. A. Gardner) and the Acting Government Botanist (G. R. Meadly), to quote from a departmental report submitted by the latter, "did not reveal any plant that could be strongly suspected of causing 'falling disease.' The only species present in quantity and common to all areas was drooping flowered clover."

In order to make sure, however, that a poisonous plant was not responsible for the disease, the only three considered suspicious—including Emu bush (*Podocarpus drouyiana*)—were tested by feeding them to experimental cattle. Feeding tests

were carried out in 1936 by E. F. Twaddle and in 1937 by H.T.B.H. Results were entirely negative.

Although drooping flowered clover is considered a good pasture plant the constant association suggests that it may in some way contribute to the occurrence of the disease and it will be regarded with some suspicion until further investigations are completed.

It being known that some pasture plants, including clovers, may at times become dangerous to stock owing to development of prussic acid, pastures and animals dead of the disease were tested for this poison. The result was negative.

Anaemia and Mineral Deficiency.

Microscopic examination of blood from fresh cases of the disease investigated in 1937, indicated that affected animals had suffered from anaemia.

Following this discovery during 1937 and 1938 extensive examinations of blood of cows in affected, and to a less extent in non-affected herds, have been carried out. These showed that many cows in the herd, despite apparent normal health, were affected with a severe anaemia. This anaemia occurs during the period of the year when cows are susceptible to falling disease and natural recovery begins about the same time as losses from the disease, cease. The condition of the blood returns to normal during November and December.

The occurrence of severe anaemia in milking cows coincidently with the period of susceptibility to falling disease appears to be very significant. There are indications that this anaemia and the presence of iron accumulations in the organs of animals dead of falling disease might be due to a mineral deficiency or deficiencies.

During 1938 an experiment was carried out at the Jindong Bank Depot for the purpose of determining any relationship between falling disease, anaemia and mineral deficiency. Five cows were given daily a "complete mineral supplement" (iron, copper, cobalt, manganese, nickel, zinc) and five cows which received no minerals were kept as controls. The control group showed definite anaemia during October, whereas the group receiving minerals remained normal throughout.

No cases of falling disease developed in the experimental herd, possibly on account of the comparatively poor growth of clover in the pasture that season.

The occurrence of diseased conditions in young animals* and the type of anaemia occurring in the district, suggested the probability of copper deficiency in the affected area.

During 1937 an experiment was carried out with a view to determining the effect of feeding copper supplement to anaemic cows. Unfortunately this was commenced late in the season and a natural recovery (seasonal—see earlier) in the portion of the herd not receiving copper obscured the results.

In the past season determinations carried out by the Assistant Animal Nutrition Officer and which will be reported in detail later, indicate that the copper status of both animals and pastures in the affected area is well below normal.

Further and more extensive experiments are now being undertaken in order to determine the relationship of mineral deficiency to the anaemia and to falling disease.

* It was known from the earliest days of settlement that much of the coastal fringe—Busselton district—was "unsound" for breeding stock—lambs developed ataxia ("rickets") and foals and calves were unthrifty, poorly grown, "stood up on their toes" and developed malformed legs. Ataxia has been shown to be due to copper deficiency and the other conditions are ascribed to a similar cause.

Recently Harley has ascertained that similar conditions are now quite common in the "falling disease" area.

It appears extremely unlikely that a mineral deficiency by itself could be responsible for sudden death. On the other hand, it appears possible that mineral deficiency and anaemia might predispose to falling disease.

This study, associated with further blood examinations, and attempts to reproduce the disease, will constitute the main lines of investigation projected this season.

Recommendation.

It is impossible at this stage of the investigation to make any definite recommendations for the control of the disease.

At the same time, in view of the serious losses occurring annually and the probable long duration of the investigation we feel justified in making a suggestion.

There is much evidence that stock in the "falling disease" area are affected with a deficiency of copper and/or other minerals, and we are of the opinion that this may in some way be associated with the disease.

Field observations indicate—as one would expect—that a limonite lick (Denmark No. 1) which provides a fairly complete mineral supplement, beneficially affects the health and condition of the blood of milking cows receiving adequate quantities.

It is suggested, therefore, that settlers in the affected area would be well advised to feed Denmark No. 1 lick to their milking cows, particularly during the months of May-December: a daily dose of 1½ ounces should be adequate.

Acknowledgment.

The authors desire to acknowledge their appreciation of the assistance afforded by the Agricultural Bank in providing locations and animals for experimental work. The officials, notably those in the Busselton Branch, assisted in many ways and were always courteous and helpful. Mr. J. M. Nelson, Dairy Supervisor, Vasse, was also very helpful.

We are indebted to many settlers for reports of cases and for making their herds available for blood determinations. Mr. F. Wilkinson of Metricup, in addition, further assisted by looking after experimental animals depastured on his holding.

TUBERCLE-FREE HERDS.

The following herds have been declared free of Tuberculosis in accordance with the requirements of the scheme for the certifying of herds tubercle free, and unless otherwise declared the Certificate remains in force until the date shown in respect of each herd:—

Certificate No.	Owner and Address.	No. of Cattle Tested.	Date of Expiry.
1	A. Groves, Toodyay and Melville ...	226	19-1-40
2	School of Agriculture, Narrogin ...	39	17-12-39

PHALARIS TUBEROSA.

TOOWOOMBA CANARY GRASS.

H. G. ELLIOTT,
Agrostologist.

Phalaris tuberosa is a grass which has proved one of the most hardy of our introduced species. As far as can be ascertained it was first imported into Australia by the Queensland Department of Agriculture from America as *Phalaris bulbosa* for trial at the Toowoomba Experimental Farm in 1884, hence the name Toowoomba Canary Grass. It is interesting to note that it was not until October, 1908, that the first favourable reports of this grass were published in the Agricultural Gazette of New South Wales. The following gives an abstract of some of the reports of the experimental farms as given in the article.

Hawkesbury Agricultural College.- "The leaves and stems of the *Phalaris* are soft and succulent, and the plant grows to a height of 2½ feet. It is a splendid grass for winter and spring feed and gives good growth to December when it seeds. The plants are very frost and apparently very drought resistant."

At the Wagga Experimental Farm it was reported "to be very promising as a pasture grass."

The Bathurst Experimental Farm reported that "the grass made good growth throughout the summer months, grew continuously through the winter and withstood frosting. The crowns of the plant are compact and withstand considerable trampling."

From the above reports it will be seen that this plant was considered to be a valuable asset as a pasture species.

Until about eight years ago this grass was known as *Phalaris bulbosa* or *P. commutata*. Since that time, however, botanists have agreed that the correct nomenclature is *P. tuberosa*, the name by which it is known to-day.

In Western Australia, as far as can be ascertained, it was first grown successfully by Mr. A. Snell at Harvey, and also by Sgt. W. Brodie at the Police Station at Donnybrook. Excellent growth of *Phalaris* plants can be seen on the original areas, and also along the adjoining roadways at these original sites.

Except where grown under irrigated conditions, *Phalaris tuberosa* gives early autumn, winter and spring growth, and its productiveness is practically nil during the period from early summer until the event of the first autumn rains. It is capable of adapting itself to wet cold conditions and also to extreme dryness. Generally speaking, its adaptability to extreme conditions is amazing.

In Western Australia this grass appears to be well adapted to large areas of land receiving a rainfall of 17 inches or over, which is of the winter rainfall and summer drought type. At Wongan Hills Research Station, during the last year (1938) with a rainfall of 12.76 inches its persistence was remarkable, but very little growth was obtained, this grass, however, had been growing without a legume association.

The areas of *Phalaris tuberosa* growing in Western Australia are still comparatively few and the factors that appear to have contributed towards the restricted use of this grass are:—

1. In the early introductions of seed there was present a high percentage of seeds of *P. minor*, an inferior annual species. Also the seed obtained gave a low germination, with a subsequent poor stand.
2. The grass is only a comparatively recent introduction into Western Australia.

3. The absence or comparatively poor spread of Phalaris plants on non-cultivated land by means of seed.
4. The early lack of adequate knowledge with reference to the methods of soil preparation and type, seeding and subsequent fertilizing of this grass.
5. The comparatively high price of the seed.

*Plant Description**: "Perennial, caespitose, the culms more or less swollen at the basal internodes, or forming hard woody stocks, 2-4 feet in height, erect or ascending, sometimes geniculate below. Sheaths much shorter than the upper internodes, tight and striate; ligules long, thin, white and hyaline, truncate and soon becoming lacerated. Leaf blades firm, rather soft, prominently striate, tapering into long, weak, fine points. Panicle cylindrical, spikelike, up to five and a half inches in length, compact, tapering at both ends or sometimes broader at the base, the spikelets usually erect, the peduncles ultimately long exserted.

Glumes subequal lanceolate, rather straight, more or less acute but not long pointed, 3-nerved, the lateral nerves prominent; margins wide, hyaline but firm, keeled, flat, the keel produced into a prominent dorsal wing extending over the upper two-thirds of the glume and gradually narrowed at each end, minutely serrulate or entire and not notched. Sterile lemmas not very unequal, the lower about one-quarter, the upper one-third the length of the fertile lemma, both sparsely hairy and appressed to the fertile lemma, more or less linear and concave. Fertile lemma acutely ovate-elliptical, silky with appressed hairs, faintly nerved, becoming firm in fruit; palea acute, slightly less in length than the fertile lemma, glabrous except for the terminal tuft of a few short hairs."

Seed and Strain.—Owing to the difficulty of detecting the difference between the seed of the valuable perennial type, *P. tuberosa*, and that of the inferior annual, *P. minor*, it is essential for the buyer to purchase certified seed only. The seed tester can, however, determine the difference between the two by the following processes:—

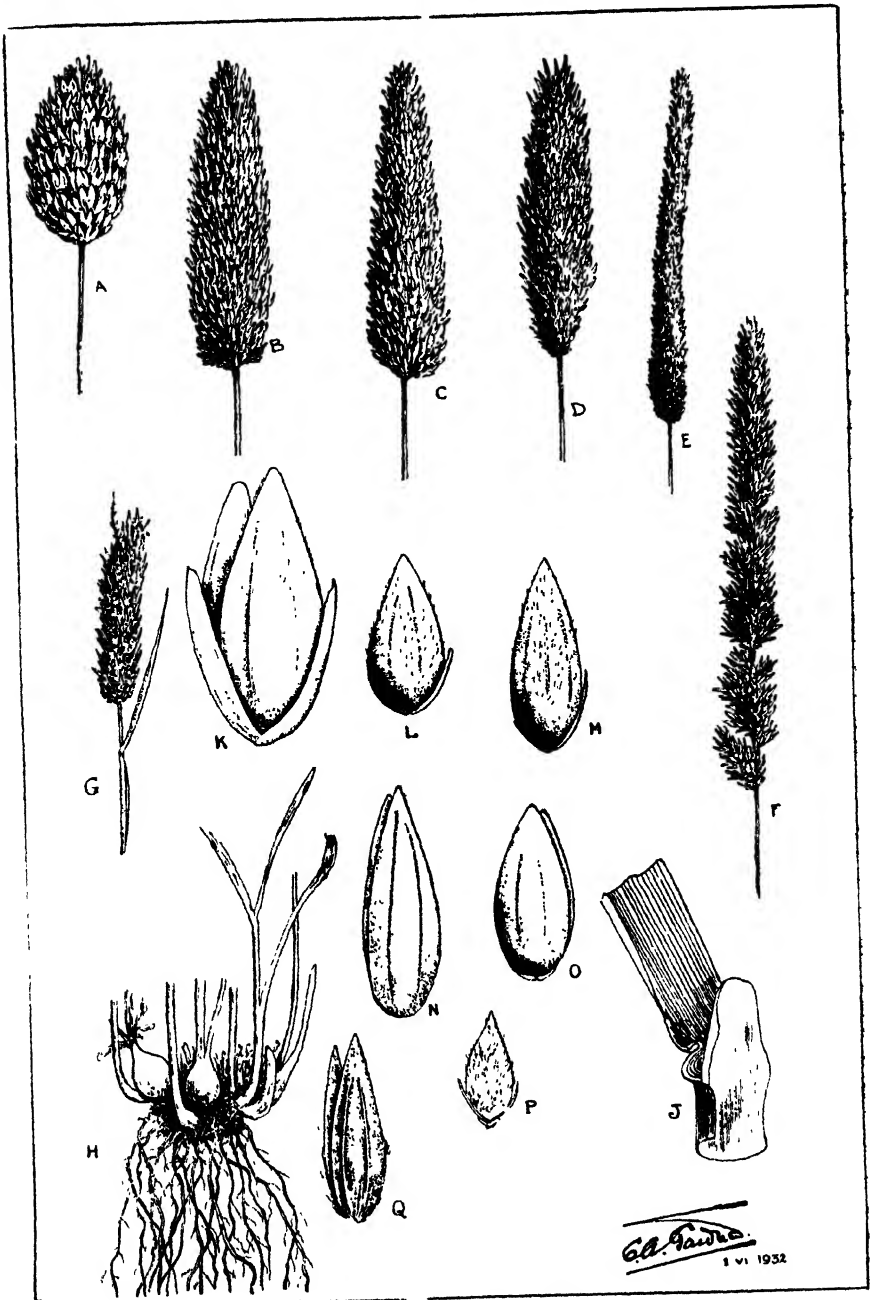
1. On the germinating filter paper *P. tuberosa* shows a white tip to the rootlets, while *P. Minor* definitely shows a pink tip.
2. Under the ultra-violet light (quartz lamp), seeds of the *P. tuberosa* when germinated on filter paper will show the roots clearly defined, while with the *P. Minor* the rootlets are not at all visible.

The Departments of Agriculture in New South Wales and South Australia have instituted a certification scheme for *Phalaris tuberosa* seed and farmers are recommended to purchase only certified seed when obtaining their requirements. Both the South Australian and New South Wales certified seed have given and are giving good results in this State.

Where to Sow.—*Phalaris tuberosa* is able to adapt itself to a wide range of climatic conditions in Western Australia. It is growing successfully in areas of 17 to 40 inches of winter rainfall, in summer drought conditions, and also is being grown quite successfully in our irrigation areas; it can, therefore, be realised that the value of this grass in relationship to its wide range of climatic conditions is very extensive. At the Waite Institute in South Australia, it has proved to be one of the best perennial grasses for districts where the summer months are hot and dry and the average annual rainfall is below 24 inches.

This grass appears to be best suited to the heavier soil types, but will grow well on the lighter soils which have a clay subsoil not more than 12 inches below the surface. As an association with a legume is essential, it is recommended to

* From article by C. A. Gardner and G. R. Meadley—Canary Grasses of W.A. Leaflet No. 353, Journal Department of Agriculture, W.A., Vol. IX., pp. 275-285, 1932.



EXPLANATION OF PLATE.

A.—G. Diagrams of panicles (reduced in size).

A. *Phalaris canariensis*, Linn. B. *P. minor*, Retz. C. *P. tuberosa*, Linn. D. *P. caerulescens*, Desf. E. *P. angusta*, Nees. F. *P. arundinacea*, Linn. G. *P. paradoxa*, Linn. H. Diagram illustrating the growth of *P. tuberosa*, showing the internodial swellings—the "tubers." J. Diagram of the ligule of *Phalaris*.

K.—Q. Drawings of fruits (magnified eight times).

K. *P. canariensis*. L. *P. minor*. M. *P. tuberosa*. N. *P. caerulescens*. O. *P. paradoxa*. P. *P. angusta*. Q. *P. arundinacea*.

establish it in old subterranean clover paddocks or sow the variety of subterranean clover must suitable to the district at the same time.

Soil Preparation.– In areas of 25 inches and under this is a most important factor for the future establishment and growth of this grass. It is recommended that a well prepared fallow, free of weeds and well consolidated be used. If this is available early seeding can be carried out. A firm consolidated seed bed is most essential for success. If fallowed land is not available the area to be sown should be lightly ploughed and worked down. After weed germination further cultivation will be required to destroy the weeds. After cultivation the area should be well rolled with a T-bar roller, the seed to be sown about mid-May and rolled or lightly harrowed in. Good results have been obtained by cultivating the area with a "combine" or springtyne cultivator after the weed germination has occurred. The seed is then mixed with superphosphate just prior to it being sown with the "combine" or drill set so that shallow planting is carried out. On lighter types of soil, deeper planting to 1 inch can be adopted. It is recommended, however, that a well prepared seed bed be used, as a little extra trouble in the early stages is well repaid later.

Time to Sow.—The seed may be sown from the middle of April on well worked fallow, until mid-June in the higher rainfall areas. Under irrigated conditions excellent results have been obtained from spring planting, and this is recommended when an association with white clover is required.

Rate of Seeding.—Under all conditions 2 lbs. of seed per acre is recommended and if subterranean clover seed is being sown at the same time, 4 lbs. of subterranean clover seed and 2 lbs. of *Phalaris tuberosa* seed per acre would be required. In the irrigation areas 2-3 lbs. of *Phalaris* and 2 lbs. of white clover seed per acre would be sufficient. It is not recommended to mix any seed of the ryegrasses with *Phalaris* at the time of establishment, owing to the vigorous nature of their growth in the early stages, which is detrimental to the establishment of the *Phalaris* unless excellent subsequent management with grazing is carried out. It must be remembered always that this grass is highly sensitive to competition in the early stages of growth, from any vigorous growing grass or weed, such as capeweed. Clovers such as subterranean clover and white clover can, however, be grown, and are desirable in the initial establishment of *Phalaris.*

Fertiliser.—A least 2 cwts. of superphosphate per acre should be used at the time of establishment, and a subsequent application of 1 cwt. per acre in the spring is advantageous. Two to 3 cwts. per annum should be used in the following years as a top dressing. On new land and unfallowed land that has not been under subterranean clover previously the using of 1 cwt. of sulphate of ammonia per acre at the time of planting may be beneficial.

Management.—During the first year it is essential that weeds or any vigorous growing plants should not be allowed to dominate the young *Phalaris* plants. If necessary, infrequent quick, heavy grazing, should be carried out, and any subsequent grazing should not take place at closer intervals than 6-10 weeks, according to growth. Early in October, if weeds are still troublesome, mowing should be carried out and the field closed up to allow the *Phalaris* plants to produce seed heads. Once the plants have seeded grazing can then be carried out more or less indiscriminately until the autumn rains commence, then the grazing periods should be in about 6 weekly intervals. Once established, *Phalaris tuberosa* is thoroughly perennial, increases its basal size and, grazed judicially, forms a good turf in association with clover. It is succulent and palatable to stock of all kinds. It is a strong grower, and being a deep rooting plant is reasonably drought resistant.

TANGIER PEA.*

G. K. BARON HAY, Superintendent of Dairying.

H. G. ELLIOTT, Agrostologist.

INTRODUCTION.

The Tangier Pea (*Lathyrus tingitanus L.*) is an annual indigenous to Northern Africa, but since has been grown as an ornamental and fodder plant in Europe and America for many years.

It was first recommended and grown as fodder by Dr. Trabut, of Algeria, where it is used as a winter forage. It is cultivated also in the Canary Islands and Morocco. The first record of its introduction into the United States is given by C. R. Ball[1] in 1900, and it was not until some 20 years later that its great value as a fodder and green manuring crop was recognised.

C. V. Piper, United States Department of Agriculture, reports in 1922[2]:—

> "It has given the largest yields of green matter to the acre of any annual legume grown in California. The dense growth chokes out weeds completely. It is a good green manuring crop, but the seed has been hard to get. There is hope that this difficulty may be overcome."

The Tangier pea is also cultivated as a fodder plant in the south of France, where it is said to be very hardy, and able to withstand a temperature as low as 26° F. In this connection P. de Sorney[8] reports:—

> "It is a first class fodder plant and thrives very well. It is sown at the beginning of the rains and its stems rapidly cover the soil. Cattle eat it readily. Attempts should be made to acclimatise this legume in subtropical countries."

Mr. W. E. Barker,[4] Sequin, Washington, writes in 1923:—

> "I grew the Tangier pea on the poorest bits of land on the farm that had been cropped to wheat for 50 years. It grew to about 7 feet high and made an impenetrable jungle."

On reading these eulogistic reports during 1925, it was thought possible that the Tangier pea would fill a useful place in agriculture in this State, and a small packet of seed, 2 ounces, was first brought into Western Australia and secured through the courtesy of Prof. P. B. Kennedy of the Agricultural Experimental Station of California. These seeds were distributed among the State Research Stations at Nabawa, Merredin, Wongan Hills and Denmark and also Mr. A. T. O'Connell, Dwarda. A careful perusal of the results obtained from a large number of trials during the years 1926-29 showed that where cultural operations had been reasonable, good results were obtained. It was noticed, however, that in almost every instance, some of the plants failed, but all failures showed similar characteristics. These features were very stunted growth, failure to develop stool and a pink to reddish discolouration of the leaves and stems. It was common to see plants only 9 inches high when six months old, while plants in the same field and planted on the same day were 7-8 feet high. This condition was found to be associated with lack of inoculation of the Tangier peas with the necessary nitrogen fixing bacteria.

The crop appears to have, at the present time, a higher commercial value for seed production than for forage use. There has been a steadily increasing market for the seed in this State, and to some extent in the Eastern States, at prices that are quite satisfactory to growers.

* Revised from the article of the same name by G. K. Baron-Hay, Superintendent of Dairying, published in this Journal, Vol. 13, No. 4, December, 1936, pp. 508-513, and which was subsequently issued as Leaflet No. 497.

DESCRIPTION.

The Tangier pea (*Lathyrus tingitanus*) is an annual leguminous plant, which in general appearance and growth resembles the ornamental sweet pea (*L. odoratum*). It is a strong grower with numerous large nodules on its roots. During the winter months, however, the plant shows slight growth only, but with the event of warmer weather in the early spring, the growth is very rapid and strong and during September it quickly attains a height from 3 to 7 feet in a tangled mass, producing a dense covering which chokes out all but the strongest weeds.

The plant is smooth throughout with coarse stems and prominent stipules. The leaves consist of a pair of large leaflets and a large branched tendril terminating the mid-rib of the leaf. From the axils arise stalks which bear two to three flower clusters of bright scarlet flowers, which are about the size of small sweet pea blossoms. The pods are about 3 in. long, containing five to seven seeds. The seeds are brown, eliptical, somewhat flattened and about ¼ in. long. The hilum or scar is whitish, and ⅛ in. long. This pea is drought resistant to a high degree, this being due to a deep rooting habit.

RELATED SPECIES.

The genus *Lathyrus* is represented by about 100 species, growing generally in the Northern Hemisphere and a few in the mountains of tropical Africa and some in South America. Two species which have given some promise in this State are (1) the grass pea (*L. sativus*), also known as the Swiss pea. This is a much earlier species than the Tangier pea and is in full flower by the middle of October. The yield of green material and seed is good, but not equal to the Tangier pea; and (2) *L. annus*. This species has a much finer type of stem and smaller leaves than the Tangier. Rapid growth does not commence until early September, and flowering begins early in November. This species is a very heavy yielder of seed, and produces a good bulk of green material.

The comparisons of these *Lathyrus* species were made by growing them at the Denmark Research Station.

WHERE TO SOW.

In Western Australia the Tangier peas have, generally, succeeded best on well drained loams and sandy loams of reasonable fertility. Good drainage is one of the most necessary requirements for successful production. Where they are sown on poorly drained country very little growth is obtained and a red discolouration of the leaves takes place. It has, however, been grown successfully on most of our 18 in. and over rainfall areas.

TIME OF SOWING.

Usually the best time to sow the Tangier pea is immediately after the event of the general winter rain. As they have rather a long growing period, it is necessary to sow them before June, so that plant maturing will take place before the soil dries out in the late spring.

PREPARATION OF THE SEED BED.

Observations have shown that in many cases the success of a crop has been in proportion to the method, in which the seed bed has been prepared. The land can be skim ploughed and cultivated similarly to that for the sowing of a cereal crop such as oats. The seed can be either broadcasted and harrowed in, or sown from a drill or combine.

RATE AND METHOD OF SEEDING.

To obtain a heavy crop during the first season, it is recommended that up to 30 lbs. of seed per acre be planted, with 1 to 1½ cwts. of superphosphate. Good results can be obtained, however, in the second year, by planting 8 to 10 lbs. of seed per acre with a similar quantity of superphosphate. For hay and silage, crops, Tangier peas can be grown in association with oats, the rate of seeding being 5 to 8 lbs. of Tangier peas with 1 bushel of oats, and an application of 1½ cwt. of superphosphate. For green manuring purposes, the seeding rate depends very largely upon the amount of material desired for turning in, and upon the cost of the seed. Seed rates as high as 40 lbs. per acre may be required. The seed can be sown through a drill or combine to a depth of 1 in. to 1½ in. Light harrows should follow after the drill or combine. When sown broadcast, however, it is necessary to use good spike harrows for incorporating the seed into the ground.

INOCULATION.

The Tangier pea, being a legume, requires inoculation for the best crop production, and it cannot thrive without the assistance of nitrogenous fertilisers unless the necessary nitrogen fixing bacteria are found in association with it, and growing

TANGIER PEAS

Demonstration showing the effects of want of inoculation. Ladies standing on the uninoculated patch. Hat can be seen on gentleman standing in peas to the left of photo.

in colonies or nodules on its roots. The nodules produced on the roots of vigorous healthy Tangier peas are large and numerous. The absence of the nitrogen fixing organisms has been responsible for a number of failures in the initial establishment of the Tangier pea in Western Australia. The inoculation of the seed may be done with cultures as prepared by the Department of Agriculture, and it is advisable, after inoculating the seed, that the inoculated seed should not be exposed to direct sunlight. The seed should be inoculated just prior to seeding. The cost of inoculation is so small that no seeding should be carried out on land which has not grown Tangier or field peas previously, unless they are inoculated. This often means the

difference between the success and failure of the crop. Seed which has been inoculated should not be mixed with superphosphate prior to planting, as the superphosphate injures the bacteria. The best practical methods of sowing are those in which the inoculated seed is sown at the same time as the superphosphate, when the contact between the seed and fertiliser is only momentary, as in the case when sowing with a combine or drill. It must be remembered, however, that the ground should be wet at the time of seeding under these conditions.

USES OF THE TANGIER PEA.

The Tangier pea can be used for all types of forage, such as hay, silage, and as a green manuring crop.

1. *As a Forage Plant.*—As some guide to the feeding value of the Tangier pea, samples of the plant were submitted to the Government Analyst (Dr. E. S. Simpson) for analysis.

The following table shows the Tangier Pea compared with White Dutch Clover and the Common Vetch:—

——	Water.	Ash.	Crude Protein.	Carbohydrates.		Fat.
				Fibre.	Nitrogen Free Extract.	
White Dutch Clover	8·1	8·0	16·2	23·2	41·6	2·9
Vetches (common)	7·1	8·2	17·3	26·2	38·7	2·8
Tangier Pea	6·36	6·12	17·94	25·12	40·62	3·84

It will be seen that the Tangier Pea closely approximates to the values of these two legumes, as revealed by chemical analysis.

Mr. O'Connell reports that the pea is relished by all stock, which smashed a fence against which the plants were growing in order to reach them.

The leafage and stalks are eaten by stock, and, in Algeria and California, where considerable quantities have been fed to stock, no deleterious effects have been recorded.

TANGIER PEA STRAW.

——	Moisture.	Ash.	Crude Protein.	Carbohydrates.		Fat.
				Fibre.	Nitrogen Free Extract.	
1. Bean Straw	11·07	6·97	5·68	41·10	33·63	1·52
2. Oaten Hay	8·6	4·7	3·80	31·0	49·2	2·6
3. Oaten Straw (Stubble) ...	11·5	5·4	3·60	36·3	40·8	2·4
4. Tangier Pea Straw ...	10·0	10·64	6·42	37·10	34·06	1·78

1. Hendry, G. E.: Bean Culture in California. Bulletin 294. California Agricultural Experiment Station.
2. West Australian figures.
3. Henry and Morrison: Feeds and Feeding.
4. P. B. Kennedy: The Tangier Pea. Circular 290. University of California.

VALUE OF STRAW.

Mr. O'Connell has found that all stock—sheep, horses and cattle—eat the pea straw with relish, cattle in particular being very keen on it.

While it is not advisable that the straw should be considered suitable as a feed for stock by itself, there is no doubt that the straw, when chaffed, would make a valuable bulk feed, especially for cattle.

The above comparisons of Tangier pea straw with bean straw, oaten hay (local), and the oaten stubble indicates that the Tangier pea straw has a decided feeding value and compares more than favourably with oaten stubble.

For feeding to cattle it is advisable to chaff the straw and moisten it some hours before feeding.

3.—A SEED CROP.

One of the principal difficulties with the Tangier pea is to obtain the seed cheaply, although they have given excellent results in this State. Commercial quantities of the seed are now available in limited quantities, this being brought about largely through the efforts of Mr. O'Connell of Dwarda. The best method of harvesting the seed is as follows:—

The tangled growth is generally so large and dense that it is rather difficult to cut the material in such a manner as to make it readily available for the threshing machine. Methods used have been to cut the material at the base near the

A crop ready to harvest. The straw is fine and relished by stock

ground with a mower, and to roll the cut plants out of the way for the next cut. It is then bunched together and carted to a convenient spot for threshing. This operation should be carried out before the plants have reached full maturity, to reduce as much as possible the shedding of the seed. Very little trouble is encountered in separating the seed from the pods and straw by any ordinary threshing machine, and as there would be no weeds present, it is usual to obtain a good quality of seed that needs very little or no additional cleaning. An average of approximately 1 ton of seed can be obtained per acre. The seed weighs 60 lbs. per bushel.

SUMMARY.

1. The Tangier pea is an excellent fodder plant and useful for green manuring in districts with an 18in. winter rainfall and over.

2. Early planting (May) is recommended. As the plants grow but little during the cold winter months, this early planting is important.

3. The plants require six to seven months to reach maturity.

4. Grown with oats, produces an excellent crop for hay and silage.

5. Inoculation of seed is essential for success.

6. At least 1 to 1½ cwts. of superphosphate per acre should be applied.

8. Related species *Lathyrus annus* and *L. sativus* are showing that they can be of value as forage plants.

7. Well drained land is essential for the successful growth of Tangier peas.

References:

1. Ball, C. R.—"Grasses and Fodder Plants on the Potomac Flats," U.S. Dept. Agr., Div. Agrost., circ. 28 : 14, 1900.
2. Piper, C. V. and Pieters, A. J.—"Green manuring," U.S. Dept. Agr., Farmers' Bull. 1250 : 42, 1922.
3. P. de Sorney—"Green Manures and Manuring in the Tropics," 1916.
4. P. B. Kennedy—"The Tangier Pea," Univ. of California, circ 290, 1925.

PASTURE DEVELOPMENT.

By H. G. ELLIOTT, Agrostologist.

The four year's report on the rotational grazing demonstration under irrigated conditions being conducted on the property farmed by Mr. D. Moore and owned by Mr. A. E. Jackson, of Roelands, is now available. This demonstration, along with those on the properties of Messrs. J. Neil and C. H. Henning, of Waroona and Hamel respectively, have been conducted as a co-operative project by the State Committee of the Australian Dairy Council and the field staff of the Department of Agriculture.*

The objects of the demonstration include:—

1. The collection of data regarding the carrying capacity of small areas.
2. The collection of information as to whether it would be more profitable to establish a permanent pasture with a cover crop than to sow the perrenial pasture species alone.
3. To obtain the monthly yield of green material per acre
4. The collection of data to show the change in botanical composition due to rotational grazing under irrigated conditions.
5. To test the effect of varying the time between waterings during the irrigation season.

Full particulars with reference to soil type, seed mixtures, fertilisers, cultivation, irrigation and cover crop for each field have been given in detail in previous reports. The following details give further results of the experiment for the year ending the 31st December, 1938.

Fertiliser.—The rate of application for the fertilisers for the fourth year, 1938, was slightly lower than that of the third year, being 5 cwt. per acre, applied in three applications, the main application being given in the autumn.

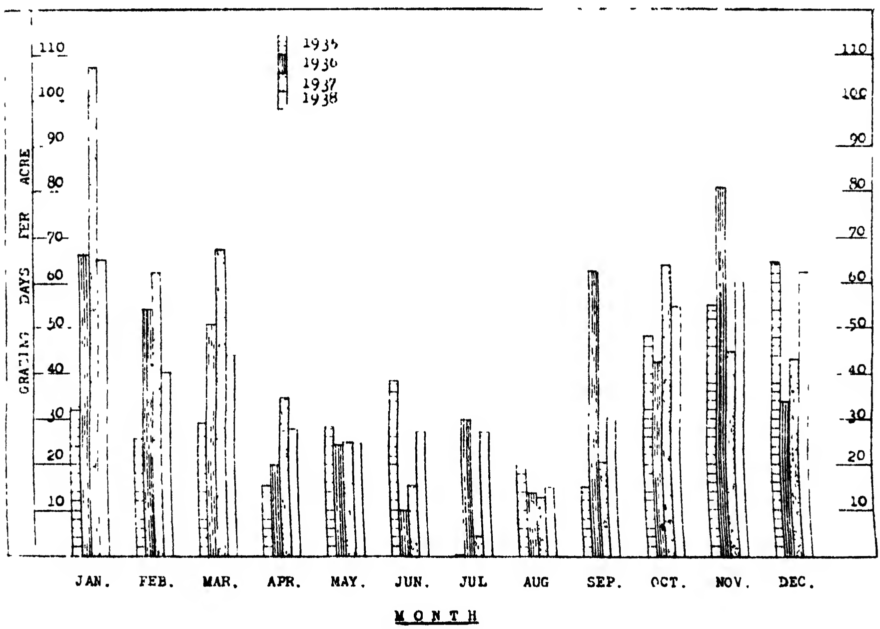
* A resume of the first three years' operations has been published in the March, 1936, 1937, and 1938 issues of this Journal.

The quantity of fertiliser applied during 1935 consisted of 904 lbs. of superphosphate and 218 lbs. of sulphate of ammonia per acre. In 1936, 374 lbs. of superphosphate and 28 lbs. of sulphate of ammonia were applied. In 1937, 600 lbs. of superphosphate were applied. It will be noticed that no sulphate of ammonia has been applied during the past two years. Early in 1936, half of each field was limed with agricultural lime, at the rate of 4 cwts. per acre. To date no effects from this application have been noticed.

Renovation.—During the middle of July, 1938, all plots received a severe surface renovation with the rotary type of renovator known as the "Sunprong." Following the double renovation which was carried out, a pasture blade type of harrows was used. All furrows were cleaned out, with a modified type of "Sunbuster" plough, this to facilitate watering during the summer months. The complete area was topped with a mower during the summer to assist in preventing seed production of the paspalum.

Irrigation.—Owing to the system of irrigation being altered to enable the Irrigation Officers to carry out a time of watering experiment no details of watering can be given. Mr. L. C. Lightfoot, Agricultural Adviser of the Irrigation Branch, has appended the details of the methods being adopted.

GRAPH 1 AVERAGE MONTHLY GRAZING DAYS (8 HOURS) PER ACRE



Above Graph No. 1 shows the monthly production in grazing days per acre for the four years. It will be seen from this graph that the average monthly grazing was 40 grazing days per acre, which is slightly lower than that of the previous two years, *i.e.*, 1937, 42.2, and 1936, 41.3. The months in which the principal reduction in grazing took place were those of January to April inclusive and October. This lighter grazing during the summer months gave rise to an increased grazing during the months of June and July. It will be seen, however, that the production for the month of August was approximately the same. The total grazing obtained from all fields averaged 480.5 grazing days per acre per annum. This is very close to the grazing figures obtained during the previous two years.

No reason can yet be given for the rapid decline in production which occurs each year during the month of February. In three years, this decline was followed by a slight increase in production for the month of March. The heavy decrease in grazing occurs during April and continues during the winter months, until the spring flush occurs in September. The winter months June to August are definitely the light production period of the year.

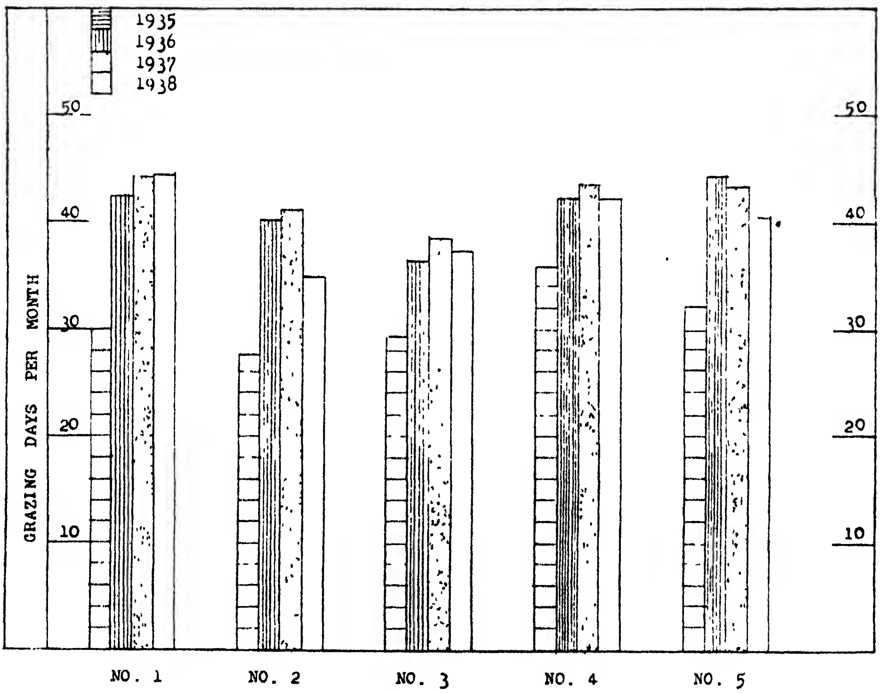
Table 1 gives the full grazing production for the years 1935 to 1938 inclusive.

TABLE 1.

Year.	Grazing hours.	Total grazing days.	Grazing days per acre.	Acres per cow.
1935	38,373	4796·6	371·2	0·97
1936	47,019	5877·4	496·1	0·73
1937	52,200	6525·0	506·6	0·72
1938	49,430	6178·7	480·5	0·76

From the above table it will be noted that the complete area has maintained a high carrying capacity, and that during the past three years it has been constant, being equivalent to approximately one cow to ¾ acre.

GRAPH 2. GRAZING DAYS 8 HOURS PER ACRE

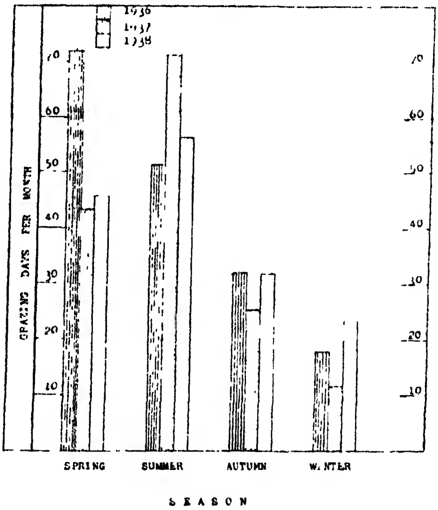


FIELD.

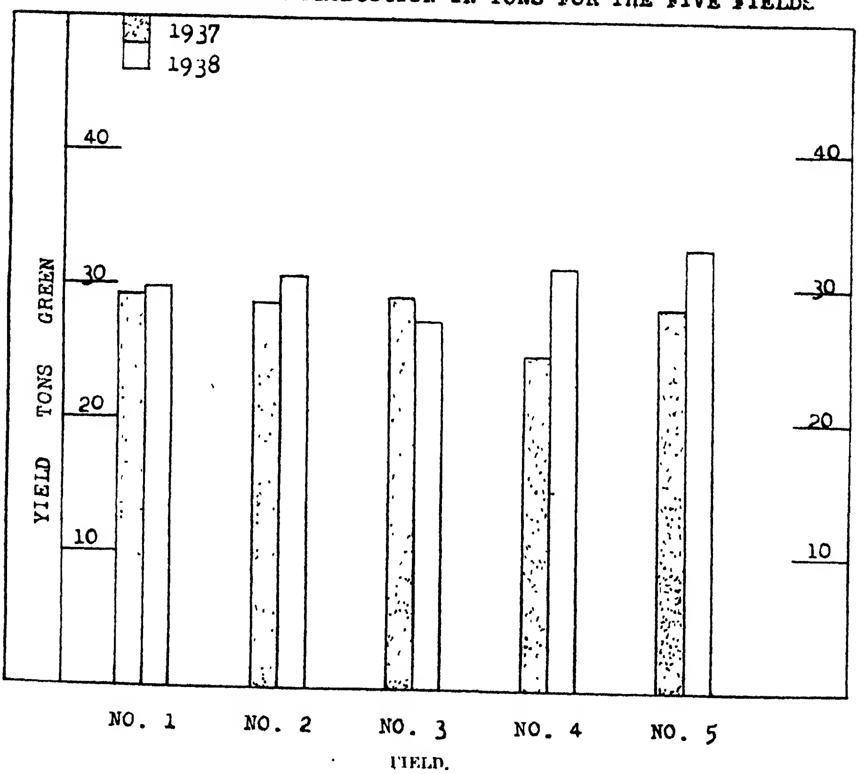
Graph 2 above shows the grazing days per acre obtained for the individual fields for the years 1935 to 1938. The most marked annual variation occurs in Field No. 3. This field initially had the heaviest cover crop, *i.e.,* Japanese Millet. This cover crop affected the constant and rapid spread of White Clover, and allowed Couch Grass to dominate in sections. It is quite obvious that no beneficial effects were obtained in establishing a permanent pasture under irrigated conditions with a heavy cover crop. Even the additional yield of the cover crop did not bring about the highest production in grazing for the first year.

Graph 3 shows the monthly variation in grazing days which occurs during the three month seasonal periods of the year. From this graph it will be noted that the spring and summer production is high, and that the summer production during the past two seasons has exceeded the spring production. It will be seen, however, that a rapid decline takes place in the autumn, and that the winter production is very low. The 1938 winter production indicates a decided improvement on the previous two years' figures. A similar rise and fall in tons of green material per acre can be noted in Graph 5.

GRAPH 3 SHOWING THREE MONTHLY SEASONAL GRAZING



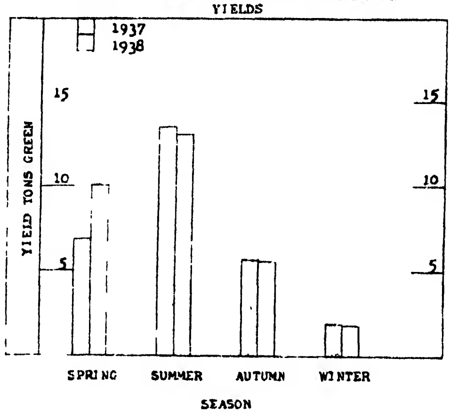
GRAPH 4 ANNUAL PRODUCTION IN TONS FOR THE FIVE FIELDS



Graph 4 gives the annual production in tons of green material for the five fields for the years 1937 and 1938. It will be noticed that very little variation

occurred in the production of the fields during the two years except in the case of Field 4, where a decided increase occurred. During the period 1937, the average production of the whole area was 28.1 tons per acre, whereas for the year 1938 the production of green material was 30.5 tons per acre.

GRAPH 5 SHOWING THREE MONTHLY SEASONAL YIELDS



The above graph gives the three monthly seasonal yields in tons of green material per acre for the two years 1937 and 1938. It will be seen from this graph that the main production occurs during the summer months December to February. Actually 42.6 per cent. of the production occurred in these months for the year 1938 as compared with 48.6 per cent for 1937. The spring production for 1938 has shown a decided increase, being 33 per cent. of the total production. It will be seen, therefore, that for the period September to February inclusive, 75.6 per cent. of the production was obtained . There was practically no alteration in the winter and autumn production for the two years, the winter production for 1938 being 6 per cent. of the total as against 7 per cent. for 1937. This shows that these three months are undoubtedly the ones where the least amount of grazing can be expected, and it is necessary for the farmers to have ample conservation for these months and also for the autumn period.

Tentative Conclusions.—The results indicate that:—

1. Rapid growing cover crops are detrimental to the initial establishment of white clover, and to a much less degree *Paspalum.* If couch grass (*Cynodion dactylon*) is present at the time of seeding, heavy cover crops will definitely assist the spread of it to the detriment of sown pastures, more particularly where these pastures are sown in the spring months.

2. Rapid growing cover crops are not recommended when establishing permanent pastures under irrigation.

3. Rates of superphosphate up to 6 cwt. per acre are considered profitable, and at least 4 to 5 cwts. should be applied annually in two or three applications, the heavier rates per acre being applied in the autumn. Indications show that summer applications of superphosphate just prior to irrigation are profitable.

4. Superphosphate and ammonia mixtures can only be recommended as an initial application at the time of planting. A minimum of 2 cwt. per acre should be applied.

5. The following seed mixtures can be recommended for irrigation areas:—
   (a) New areas where no irrigated pasture existed previously: *Paspalum dilatatum*—8 lbs. per acre; New Zealand Certified white clover—2 lbs. per acre.

(b) Where some irrigated pastures already exist: Certified perennial ryegrass—4 lbs per acre; *Paspalum dilatatum*—6 lbs. per acre; New Zealand Certified white clover—2 lbs. per acre; or

Certified perennial ryegrass—6 lbs. to 8 lbs. per acre; Certified Akaroa Cocksfoot—2 lbs. per acre; Certified white clover—2 lbs. per acre; or

Phalaris tuberosa—2 lbs. to 3 lbs. per acre; Certified white clover—2 lbs. per acre.

APPENDIX.

The irrigation schemes in this State have been designed for a monthly interval between waterings. With the introduction of better class pastures there is ample evidence to show that this interval is too long, especially during the height of the summer months.

The Irrigation Branch has designed, therefore, an experiment, the object of which is to obtain reliable data with reference to the frequency of irrigation required by permanent pastures.

For the purposes of this work a water requirement of $1\frac{1}{3}$ inches per week has been adopted tentatively. On this basis, Field No. 3 is watered at intervals of two weeks, Fields Nos. 2 and 4 at intervals of three weeks, and Fields Nos. 1 and 5 at intervals of four weeks, receiving respectively $2\frac{2}{3}$ inches, 4 inches, and $5\frac{1}{3}$ inches of water per irrigation, the water being measured by means of a series of gauges installed for this purpose.

By courtesy of the Australian Dairy Produce Board Pasture Improvement Committee (W.A.), Mr. D. W. Moore and the Dairy Branch, the experiment is located on the Council's irrigated permanent pasture paddocks, controlled for pasture experiments by the Dairy Branch and situated on the property of Mr. A. Jackson, of Roelands, which is farmed by Mr. Moore.

The co-operation of the Dairy Branch and the Agrostologist enables the effect of the various irrigation treatments on the productivity, condition and technical composition of the pastures to be measured.

It is considered that, owing to the short time the experiment has been under way, no attempt as yet can be made with reference to the drawing of any conclusions.

"THE JOURNAL OF AGRICULTURE"

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EGG-LAYING TRIALS.

MURESK AGRICULTURAL COLLEGE.

G. D. SHAW, Poultry Adviser.

The 1938-39 trial is the third of the second series conducted at Muresk Agricultural College. Seven previous trials were held prior to 1936, but a break occurred in the years 1933-35.

The duration of the trial is 48 weeks, beginning on 1st April, 1938, and ending on 2nd March, 1939.

For the present 1939-40 trial the birds were penned on 16th March, and will continue until the 1st February, 1940, and the 1940-41 trial will commence on 1st March, 1940, and continue for 48 weeks ending 29th January, 1941.

The earlier starting is considered advisable because of the local seasonal conditions. It is recognised that in Western Australia, August is the correct month for hatching and therefore the trials should commence within reasonable time 6 to 6½ months later. In the past it has been noticed that many birds had been laying before they arrived at the College and in many cases these ceased laying and then moulted. The holding of the commencement of the trial meant that the birds were in some cases eight months old, or should they be younger, then they had been late hatched, neither condition being advantageous to the stock. In order to advance the date of commencement without disorganisation, it was considered advisable to have two forward movements of 16 days rather than one of 31 days.

Breeders entered 294 birds for the 1938-39 trial. (All birds are weighed at the beginning of the trial and during the progress of the season they are check weighed for condition.)

MANAGEMENT.

The management of the Trial is in the hands of a committee which consists of the Principal of the College (Mr. W. Southern) (Chairman), the Poultry Adviser of the Department of Agriculture, Mr. G. D. Shaw, the Assistant Poultry Adviser, Mr. E. Lovegrove, Mr. S. Dolman, Cranleigh Poultry Farm, Mr. F. Landquist, York, and Mr. R. Knight, Kenwick, the three latter gentlemen being the representatives of the competitors. The Committee of Management meet at the College once a month and direct the policy of the trial.

There are 360 pens available and all birds are tested individually, all eggs being weighed daily and the scales used are tested and graduated to one-tenth of an ounce. The College is situated some 60 miles from Perth. The soil is ideal and the conditions good. Heat in summer has at times caused distress, but this factor is now held in check by the growth of lilacs which are in between the rows of the laying pens. The pens are in rows of 84 with a break in the centre of the row.

The conditions governing the 1938-39 trial were as follows:—

COMMITTEE OF MANAGEMENT.

The Committee of Management shall consist of the Principal of the College, the Poultry Adviser, Department of Agriculture, the Assistant Poultry Adviser, or officers acting in their stead, and three representatives elected from the breeders taking part in the preceding trial.

Note: The term "breeder" is given to those who have entered birds in the trials.

POWERS OF THE COMMITTEE.

The Committee shall have absolute control of the trials conducted during its tenure of office.

It shall recommend what tests are to be carried out and arrange the conditions and regulations governing the same.

The representatives elected shall take office on 1st April succeeding the date of appointment.

The Committee shall meet at such times as it may deem necessary.

The trial shall consist of the following sections:—

Section "A."—Pen of Six Birds—All Light Breeds.
Section "B."—Pen of Six Birds—All Heavy Breeds.
Section "C."—Pen of Six Birds—All Medium Heavy Breeds.

The trial shall extend from 1st April until 2nd March (48 weeks). The leading group or individual bird in each section may be allowed to remain at the College for the full period of twelve months.

Each breeder shall be charged an entrance fee of 5s. per bird, 2s. 6d. per bird to accompany application for pens. The balance of 2s. 6d. per bird is to be forwarded to the Principal, Muresk Agricultural College, within 14 days after notice of allotment of pens; otherwise pens may be allotted to other applicants and the 2s. 6d. application fee forfeited.

For any of the above sections pure-bred birds only must be entered.

All eggs shall be the property of the Muresk Agricultural College.

Each of the pullets will be single tested, housed (semi-intensive), and the individual numbers and weight of eggs will be kept.

REGULATIONS.

(1) In each section the trial will be decided by the highest number of first-grade eggs obtained by each group of birds and by each individual bird in their respective sections.

(2) Sections "A," "B," and "C."—During the first two months of the trial a first-grade egg shall weigh not less than 1¾ ozs., thereafter during the remainder of the trial a first-grade egg shall weigh not less than 2 ozs.

Second Grade.—The minimum weight of a second-grade egg shall be not more than ¼ oz. less than a first-grade egg. Second-grade eggs will be recorded but not counted.

(3) Eggs under 1½ ozs. in weight during the first two months of the trial and under 1¾ ozs. in weight during the remainder of the trial, soft-shelled, or broken will be recorded, but not counted in trial results.

(4) In all sections the actual weight of each egg shall be kept.

Note: The certificate for the winter test, 1st April to 31st July, shall be given subject to Rules 2 and 3.

(5) Progress results will be published weekly as far as practicable, and all prizes shall be awarded as soon as possible after the termination of the trial. Results to be reported under breed headings.

(6) No protest shall be considered unless received within 14 days of the alleged breach of regulations, and accompanied by a deposit of £1, which deposit shall be returned if the protest is upheld, or forfeited if, after inquiry, the protest is considered to be frivolous or without foundation.

(7) Records shall be kept of the average cost per head of food consumed.

(8) All birds to be accepted must conform to the following conditions:—

(a) Shall be the property of the breeder.

(b) Must be not less than six months and not more than nine months of age on 1st April.

(c) Must be fair specimens of the breed.

(d) Must weigh not less than—

	lbs.
Section "A"—Light Breeds—	
Leghorn, Ancona	$3\frac{3}{4}$
Minorca	4
Section "B"—Heavy Breeds—	
Australorp	5
Sussex, Langshan	5
Plymouth Rock	5
Section "C"—Medium Heavy Breeds—	
Barnevelder	5
Rhode Island Red	5
Wellsummer	$4\frac{1}{2}$
Wyandotte	$4\frac{1}{2}$

(9) All birds sent to the trial must conform with the weight prescribed in the preceding paragraph, otherwise the committee shall cancel the allotment pens, in addition to which the entrance fee may be forfeited.

(10) All birds shall be treated for vermin and delivered at the Muresk Agricultural College, Muresk, between 27th March and 31st March, inclusive, in new coops or crates, with the breeder's name and address clearly stencilled or painted thereon. Entries will not be accepted from any person whose premises are tick-infested or whose flock is suffering from any infectious or contagious disease.

(11) Freight to the College is to be prepaid or delivery will not be accepted. Freight on rejected birds must be paid by the breeder.

(12) All birds must be ringed with the numbered leg bands supplied and forwarded free to the breeder. These will correspond with the number of the pens allotted.

The pens having overhead netting, it is unnecessary to cut any bird's wing feathers.

(13) The Poultry Adviser, or his representative, shall have the power to reject any bird which, in his opinion, is not of the correct age, or which he considers does not conform in any way to rule 9, and his decision shall be final.

(14) Any bird found to be suffering from an infectious or contagious disease, or with crooked breasts, or side springs in combs will be rejected and returned, and shall be replaced by a suitable one within seven days after the notification of same. If any bird is found infested with tick the group will be rejected, the entry cancelled, and the entry fee forfeited.

(15) In the event of a bird during the course of the trial becoming diseased, incapacitated from laying, or developing vicious habits (such as egg-eating or feather-eating) it may be returned, or, on the written authority of the owner, destroyed.

Should this occur, the breeder may replace it with another bird of the same age and breed; in the case of a bird dying, replacement may be made. Any score standing to the credit of a bird which is replaced shall be struck out.

(16) No breeder shall withdraw any bird until the termination of the trial, except as provided in rule 15.

(17) The committee reserves to itself the right to inspect or to have inspected any applicant's stock with a view to determining whether the quality and character of the birds warrant the allotment of pens.

(18) (a) Any breeder taking part in the current trial will have the right of allotment of one pen of six birds per section in the succeeding trial. After such allotment new applications will have the right of allotment of one pen of six birds per section. Should there then be any vacant pens they will be allotted by ballot to any applicant.

(b) If after the allotment of pens it is ascertained that incorrect information has been furnished the allotment may be cancelled and the birds returned. In such case the entrance fee shall be forfeited and the applicant may be debarred from entry to any future trial.

(19) Any breeder violating or failing to conform to these regulations shall be subject to such disqualification as the committee may decide.

(20) Where there is a tie for any place, the award shall be given to the breeder whose bird or group (as the case may be) lays the greater total weight of first-grade eggs.

(21) While every care will be taken, the committee will not be responsible for loss or injury to any birds in any way in connection with the trial.

(22) The committee may disqualify any breeder and may refuse entry to subsequent trials where such breeder published in any way statements of records not in accordance with the official records of the trials.

(23) The committee's decision in all matters shall be final.

PRIZES.

Note:

Certificates will accompany all prizes

No prizes shall be awarded in any section unless there are at least four entries.

CHAMPION CERTIFICATE.

A champion certificate will be awarded to the group pen from sections "A," "B," and "C" obtaining the highest total of first-grade eggs during the term of the trial.

GOVERNMENT STANDARD CERTIFICATE.

A Government standard certificate and a registered sealed copper ring will be awarded to all birds laying not less than 200 first-grade eggs or over during the term of the trial.

DISCUSSION.

Some explanation with reference to the classes may not be out of place. In the schedule it will be noticed that light, heavy, and medium-heavy classes are defined by weight. This is not a clear interpretation of the classes. It has been found that the activity of the different breeds varies, so much so that the feeding of light birds must be on a different plane to the feed given to the heavy. It was found that the food giving the best results for light breeds was too fattening for the heavy breeds. This was because the heavy breeds were not as active as the light and therefore did not utilise the carbohydrates to the best advantage. Hence the heavy breeds are fed on a narrower ration than are the light breeds.

Again, the breeds placed into what is described as medium-heavy, are not necessarily lighter in weight than are the heavy breeds, but those placed in the medium-heavy class are more active than those breeds placed in the heavy class, yet not as active as those of the light breeds quoted. Hence the rations suitable for the

medium-heavy breeds should be wider than that given for the heavy breeds but narrower than that given to the light breeds. This has been satisfactory and the feeding at the laying trial is based on the article on "Feeding" published in the Journal of Agriculture, September, 1934, pages 435 onwards, and in the December, 1936, Journal, pages 465 onwards. This system of feeding allows the birds the necessary requirements of protein and carbohydrates consistent with their activities, and the noticeable factor at the completion of each trial of the second series has been that the birds have been returned to their owners in good condition, each bird having put on weight during the period, but no bird has carried superfluous fat.

Australorps again proved their superiority over the White Leghorns. There is no need for alarm at such a result, but the breeders are alive to the shortcomings and the trial for 1939-40 should show a marked improvement in production.

The following are the results of the trial ending 2nd March, 1939:—

SUMMARY.

	Score.
Section A. Team of 6 Birds—Light Breed.	
1st (Westfarmers' Cup), Mrs. E. E. Price—	
1st Grade Eggs	1,261
2nd Grade Eggs	6
2nd (Wright & Co. Trophy), Robinson Bros. (1)—	
1st Grade Eggs	1,186
2nd Grade Eggs	6
Section B. Team of 6 Birds—Heavy Breed.	
1st (W.A. Prod. Market Cup), Wyndella Poultry Farm—	
1st Grade Eggs	1,275
2nd Grade Eggs	87
2nd (R. Piercey Trophy), A. R. Caporn—	
1st Grade Eggs	1,254
2nd Grade Eggs	187
Section C. Team of 6 Birds—Medium-Heavy Breed—	
1st (Ian Hazlett Cup), F. Landquist & Son—	
1st Grade Eggs	964
2nd Grade Eggs	103
2nd (Kirkby Trophy), Cranleigh Poultry Farm—	
1st Grade Eggs	917
2nd Grade Eggs	113
Section A. Highest Single—Light Breed.	
1st (Macfarlane Cup), Runnymede Poultry Farm, Bird No. 6—	
1st Grade Eggs	241
2nd Grade Eggs	..
2nd (Jas. Goss Trophy), Mrs. E. E. Price, Bird No. 74—	
1st Grade Eggs	240
2nd Grade Eggs	1
Section B. Highest Single—Heavy Breed.	
1st (Bairds Co. Cup), M. H. Dadley, Bird No. 67—	
1st Grade Eggs	283
2nd Grade Eggs	..
2nd (Barrow Linton Trophy), Thorpe Poultry Farm, Bird No. 127—	
1st Grade Eggs	274
2nd Grade Eggs	6

Section C. Highest Single—Medium-Heavy Breed.

1st (Enston Cup), F. Landquist & Son, Bird No. 141—

1st Grade Eggs	210
2nd Grade Eggs	3

2nd (Harrold & Murray Trophy), Cranleigh Poultry Farm, Bird No. 134—

1st Grade Eggs	206
2nd Grade Eggs	1

First bird to lay 200 First Grade Eggs—

Light (J. & W. Bateman & Co. Trophy), Mrs. E. E. Price, Bird No. 74—2nd January, 1939.

Heavy (T. Newby & Co. Trophy), M. H. Dadley, Bird No. 67, 14th November, 1938.

Medium-Heavy (Spearwood Poultry Farmers' Cup), F. Landquist & Sons—No. 141—15th February, 1939.

Winter Test (1st April to 31st July).

(Trophies donated by Philip Giles, Manager of Nelson & Co., Metropolitan Markets, Perth). Score.

Team of 6 Birds—Light Breeds, 1st only, E. Singleton—

1st Grade Eggs	400
2nd Grade Eggs	1

Team of 6 Birds—Heavy Breeds, 1st only, M. Wall—

1st Grade Eggs	496
2nd Grade Eggs	48

Team of 6 Birds—Medium-Heavy Breeds, 1st only, R. Harrison—

1st Grade Eggs	398
2nd Grade Eggs	21

Summer Test—Team laying greatest number of First Grade eggs in the period 1st December-2nd March inclusive. (Teams to have laid 1,200 First Grade eggs in the period of the test.) Cups donated by the Western Ice Co.

Section A. Team of 6 Birds—Light Breeds. Mrs. E. E. Price—353 1st Grade.

Section B. Team of 6 Birds—Heavy Breeds. Thorpe Poultry Farm—275 1st Grade.

Section C. Team of 6 Birds—Medium-Heavy Breeds. No team laid 1,200 1st Grade eggs.

Special Prizes.

Robinson Trophy—Team laying lowest percentage of second grade eggs (minimum total lay of 1,000 First Grade eggs)—

M. H. Dadley—1,133 First Grade, 2 Second Grade.

A. S. Webb, Kirup, Trophy—Bird laying longest sequence of First Grade eggs after 1st June to conclusion of test—

Mrs. E. Kerr—Bird No. 4 (sequence of 97 two-ounce eggs). This bird laid a total sequence of 167 recorded eggs.

Champion Certificate—Wyndella Poultry Farm—Australorp. 1st grade eggs 1,275; 2nd grade 87.

* Under regulation No. 21, total weight of First Grade eggs showed:—

Thorpe Poultry Farm—618 ozs.

Wyndella Poultry Farm—602.1 ozs.

DETAILED RESULTS.

SECTION "A" (LIGHT BREEDS)—TEAMS OF SIX BIRDS.

Name of Competitor and Birds Nos.	1st.	2nd.	1st.	2nd.	1st.	2nd.	1st.	2nd.	1st.	2nd.	1st.	2nd.	Totals. 1st.	Totals. 2nd.
Runnymede Poultry Farm (1-6) ..	148	96	187	3	218	6	153	2	229	3	242	...	1,176	110
Cranleigh Poultry Farm (7-12) ...	216	...	200	1	125	15	194	4	67	134	214	8	1,016	162
Webb's Hatchery (13-18)	225	...	165	2	141	16	136	4	222	5	116	3	1,005	30
E. Singleton (19-24)	166	10	209	3	205	13	163	69	148	12	201	...	1,092	107
R. Lowe (25-30)	194	8	65	...	165	1	196	2	48	30	110	74	778	115
Mrs. R. Lowe (31-36)	133	34	190	9	196	3	141	9	165	12	125	36	950	103
Thorpe Poultry Farm (37-42) ...	160	14	136	52	152	10	142	44	198	4	116	11	904	135
M. H. Dadley (43-48)	161	20	204	...	176	5	146	4	195	3	178	1	1,060	33
Mrs. M. H. Dadley (49-54) ..	89	7	150	1	...	...	133	13	150	90	196	19	718	130
F. B. Vickers (55-60)	130	7	37	13	77	2	192	23	158	...	169	3	763	48
R. Harrison (61-66)	162	1	179	12	209	15	221	2	153	...	46	...	970	30
E. E. Price (67-72)	153	3	163	1	161	...	186	2	187	...	194	...	1,044	6
Mrs. E. E. Price (73-78)	227	...	240	1	235	...	189	2	183	...	187	3	1,261	6
H. P. Chalmer (79-84)	172	31	69	78	236	2	193	6	198	11	66	9	934	137
Robinson Bros. (1) (85-90) ...	199	...	155	1	169	4	227	...	206	...	230	1	1,186	6
Robinson Bros. (2) (91-96) ...	202	3	204	2	221	...	172	1	147	...	194	...	1,140	6
T. Gent (97-102)	189	6	203	8	40	43	94	124	128	67	139	29	793	277
H. Jager (103-108)	172	...	196	8	227	...	186	...	142	7	163	63	1,086	78
W. G. Hall (109-114)	188	6	134	57	161	12	164	45	153	65	147	61	947	246
R. Knight (115-120)	185	...	147	50	190	4	166	70	156	49	102	113	946	286

DETAILED RESULTS—*continued.*

SECTION "B" (HEAVY BREEDS)—TEAMS OF SIX BIRDS.

Name of Competitor and Birds Nos.	1st.	2nd.	1st.	2nd.	1st.	2nd.	1st.	2nd.	1st.	2nd.	1st.	2nd.	Totals. 1st.	Totals. 2nd.
E. Kerr (1–6)	231	...	187	...	231	1	228	14	252	...	11	1	1,140	16
F. Landquist & Son (7–12)	196	...	183	2	197	4	188	16	148	29	234	16	1,146	67
Cranleigh Poultry Farm (13–18)	207	7	166	...	150	31	178	...	219	1	86	94	1,006	133
Wyndella Poultry Farm (19–24)	233	15	224	9	225	4	198	2	175	56	220	1	1,275	87
A. S. Webb (25–30)	50	6	160	3	197	24	126	2	128	94	167	...	828	129
Robinson Bros. (1) (31–36)	223	1	149	26	142	105	147	...	212	23	174	8	1,048	163
Robinson Bros. (2) (37–42)	231	1	63	55	138	55	101	1	218	...	77	35	828	147
R. Harrison (43–48)	231	...	214	20	40	4	235	1	142	78	227	2	1,089	105
E. E. Price (49–54)	84	...	54	7	182	...	185	7	165	13	239	33	909	60
Mrs. E. E. Price (55–60)	165	3	166	15	145	3	199	3	48	3	172	6	895	33
Runnymede Poultry Farm (61–66)	191	...	126	58	210	10	244	11	173	2	21	170	965	251
M. H. Dadley (67–72)	283*	...	203	...	176	...	193	...	30	...	248	2	1,133	2
Mrs. M. H. Dadley (73–78)	95	146	70	175	202	66	226	14	162	7	206	40	961	448
R. A. Dusting (79–84)	215	9	200	10	193	1	179	3	86	23	89	5	962	51
Sudell & Sons (121–126)	166	1	206	2	159	...	66	102	190	3	203	11	990	119
Thorpe Poultry Farm (127–132)	274	6	245	...	235	3	175	1	114	...	210	6	1,253	16
Geo. Davey & Son (133–138)	200	2	170	53	180	44	68	139	209	1	149	10	976	249
N. T. Wilkinson (139–144)	202	22	122	98	218	4	203	46	200	16	183	15	1,128	201
Sundale Poultry Farm (145–150)	180	22	245	1	71	...	239	30	222	8	186	1	1,142	62
R. Caporn (151–156)	220	15	163	53	226	24	173	51	226	41	246	3	1,254	187
W. G. Hall (157–162)	214	...	262	9	191	60	170	2	185	82	78	5	1,100	158
M. Wall (163–168)	248	18	182	40	171	77	239	7	193	20	210	41	1,243	203

* Bird 67 (M. H. Dadley) was held at the College for the 365 days and completed a creditable performance by laying 300 First Grade eggs and no Second Grade eggs.

DETAILED RESULTS—*continued.*

SECTION "C" (MEDIUM HEAVY BREEDS)—TEAMS OF SIX BIRDS.

Name of Competitor and Birds Nos.	1st.	2nd.	1st.	2nd.	1st.	2nd.	1st.	2nd.	1st.	2nd.	1st.	2nd.	Totals.	
													1st.	2nd.
Runnymede Poultry Farm (127–132)	64	2	126	..	89	...	136	3	131	23	125	4	671	32
Cranleigh Poultry Farm (133–138) ...	165	67	206	1	150	..	101	2	129	43	167	...	917	113
F. Landquist & Son (139–144) ...	181	7	168	.	210	3	129	91	87	...	189	2	964	103
R. Harrison (145–150)	129	20	151	39	183	..	186	...	135	8	127	63	911	130
Robinson Bros. (151–156)	63	130	73	82	86	8	180	3	136	...	188	7	726	230
G. Dolman (157–162)	136	61	172	15	180	25	122	22	153	11	130	24	893	158
J. N. Enston (163–168)	140	25	116	31	31	3	195	10	151	38	196	4	829	111

MORTALITY.

The following is a comparison of the deaths for 1936–37, 1937–38 and 1938–39 :—

	1936–37.		1937–38.		1938–39.	
	Deaths.	%	Deaths.	%	Deaths.	%
White Leghorns	6	6	7	7·3	8	6·4
Australorps	6	5·36	8	7·1	14	10·3
Rhode Island Reds	2	5·7	3	8	5	11·1

AVERAGES.

MONTHLY AVERAGES.

Month.	No. of Bird and Breed.		Total Number of 1st Grade Eggs Laid.	Average.	Total Number of 2nd Grade Eggs Laid.	Average.	Total Average for all Grades.
April	120	W.L.	1,269	10·57	224	1·86	12·43
	132	Aus.	2,076	15·73	159	1·20	16·93
	42	R.I.R.	576	13·71	220	52	14·23
May	120	W.L.	1,758	13·16	16	·13	13·29
	132	Aus.	2,349	17 79	71	·5	18·29
	42	R.I.R.	625	14·88	3	07	14·95
June . ..	120	W.L.	1,195	9·95	140	1 16	11·11
	132	Aus.	1,704	12·91	379	2 87	15·78
	42	R.I.R.	485	11·54	80	1 90	13·44
July	120	W.L.	1,459	12·15	81	·67	12 82
	132	Aus.	1,912	14·48	225	1 70	16·18
	42	R.I.R.	636	15 14	46	1·09	16·23
August	120	W.L.	2,279	18·99	46	·38	19·37
	132	Aus.	2,619	19·84	199	1·5	21·34
	42	R.I.R.	783	18·64	58	1·38	20 02
September ..	120	W.L.	2,450	20·41	125	1·04	21·45
	132	Aus.	2,701	20·46	303	2·29	22 75
	42	R.I.R.	737	17·54	105	2 5	20 04
October	120	W.L.	2,439	20·32	212	1 76	22·08
	131	Aus.	2,678	20·44	238	1·81	22·25
	42	R.I.R.	642	15 28	148	3·52	18·80
November ...	118	W.L.	2,091	17·72	312	2·64	20·36
	130	Aus.	2,254	17·33	316	2·43	19·76
	42	R.I.R.	482	11·47	130	3·09	14·56
December ...	117	W.L.	1,823	15·58	373	3·18	18·76
	127	Aus.	2,086	16·42	337	2·65	19·07
	41	R.I.R.	...	...	...	..	..
January	117	W.L.	1,780	15·21	323	2·76	17·97
	127	Aus.	1,660	13·07	365	2·87	15·94
	40	R.I.R.	272	6·8	95	2·37	9·17
February ...	115	W.L.	1,406	12·22	199	1·72	13·94
	124	Aus.	1,432	11·54	295	2·38	13·92
	40	R.I.R.	294	7·35	94	2·35	9·7

YEARLY AVERAGES.

	1st Grade.	2nd Grade.	Average All Grades.
White Leghorns	166.1	17.2	183.3
Australorps	179	22.2	201.2
Rhode Island Reds	142.4	21.1	163.5

AVERAGE FOR ALL BIRDS IN TEST.

	1937-8.			1938-9.		
	1st Grade.	2nd Grade	Total.	1st Grade	2nd Grade	Total.
All birds ..	164.8	23.5	188.3	168.5	20	188.5

WINTER TEST RESULTS.

(1st April-31st July; 122 days.)

Winners.	No. of Eggs.	Average.
Light Breeds—E. Singleton, White Leghorns ..	400	66.6
Heavy Breeds—M. Wall, Australorps	496	82.6
Medium-Heavy Breeds—R. Harrison, Rhode Island Reds	398	66.3

LAYING AVERAGES FOR WINTER TEST.

(1st April-31st July; 122 days.)

	1st Grade.	2nd Grade.	All Grades
Light Breeds—White Leghorns ..	45.84	3.75	49.59
Heavy Breeds—Australorps	60.91	6.32	67.23
Medium-Heavy Breeds—Rhode Island Reds	55.28	3.6	55.88

SUMMER TESTS.

(1st December-2nd March; 92 days.)

Winners—

Light Breeds—Leghorns. Mrs. E. E. Price; 353 1st Grade eggs, 1 2nd Grade egg.

Heavy Breeds—Australorps. Thorpe Poultry Farm; 275 1st Grade, 8 2nd Grade.

Medium Heavy—Rhode Island Reds—No award as no team reached 1,200 eggs.

SUMMER TEST—ALL TEAMS.

(1st December-2nd March; 92 days.)

	1st Grade.	2nd Grade.	All Grades.
Light Breeds—White Leghorns ..	43.55	7.78	51.33
Heavy Breeds—Australorps	40.1	.8	40.9
Medium-Heavy—Rhode Island Reds ..	23.3	7.04	30.34

Comparison of ten leading pens during the last three years:—

	1936-7.		1937-8.		1938-9.	
	1st.	2nd.	1st.	2nd.	1st.	2nd.
10 pens White Leghorns	960.8	21.7	1,074.6	8.06	1,106.6	54.4
10 pens Australorps	1,128.6	12.11	1,268.6	7.06	1,181.4	99.9
6 pens Rhode Island Reds	798.2	220.0	901.2	149.1	902.8	123

Rhode Island Reds entered for 1936-7 consisted of 5 pens.
1937-8 „ 6 pens.
1938-9 „ 7 pens.
each 6 birds.

The following birds which laid 200 or more first-grade eggs during the 48 weeks were awarded a sealed copper ring:—

COPPER BANDED BIRDS.

Copper Band No.	Trial No.	Breed.	Owner.	Number 1st Grade Eggs.
40	3	White Leghorn	E. O. Harrison	218
41	5	do. do.	do. do.	229
42	6	do. do.	do. do.	241
43	7	do. do.	S. Dolman	216
44	8	do. do.	do.	206
45	12	do do.	do	214
46	13	do do.	W. R. Webb	225
47	17	do do.	do.	222
48	20	do. do.	E. Singleton	209
49	24	do. do.	do.	201
50	44	do. do.	M. H. Dadley	204
51	63	do. do.	R. Harrison	209
52	64	do do.	do.	221
53	73	do. do.	Mrs. E. E. Price	227
54	74	do. do	do. do.	240
55	75	do. do	do. do.	235
56	81	do. do	H. P. Chalmer	236
57	88	do. do.	Robinson Bros.	227
58	89	do. do	do. do.	206
59	90	do do.	do. do.	230
60	91	do. do	do do.	202
61	92	do do.	do do.	204
62	93	do. do.	do. do.	221
63	98	do do.	T. Gent	203
64	105	do. do	H. Jager	227
106	1	Australorp	Mrs. E. Kerr	231
107	3	do	do	231
108	4	do.	do.	228
109	5	do	do	252
110	12	do.	F. Landquist & Son	234
111	13	do	S. Dolman	207
112	17	do	do	219
113	19	do.	D F. Robinson	233
114	20	do	do. do.	224
115	21	do	do. do	225
116	24	do	do. do.	220
117	31	do.	Robinson Bros	223
118	35	do	do. do	212
119	37	do.	do. do.	231
120	43	do.	R Harrison	231
121	44	do.	do.	214
122	48	do.	do.	227
123	54	do.	E. E. Price	239
124	63	do	E. O. Harrison	210
125	64	do.	do. do.	244
126	67	do.	M. H. Dadley	283
127	68	do.	do.	203
128	72	do.	do.	248
129	75	do.	Mrs. M. H. Dadley	202
130	76	do.	do. do.	226
131	78	do.	do. do.	206
132	79	do.	R. A. Dusting	215
133	80	do.	do.	200
134	122	do.	T. Sudell & Son	206
135	126	do.	do. do.	203
136	127	do.	H. Seal	274
137	128	do.	do.	245
138	132	do.	do.	210
139	133	do.	Geo. Davey & Sons	200

COPPER BANDED BIRDS—*continued.*

Copper Band No.	Trial No.	Breed.	Owner.	Number 1st Grade Eggs.
140	137	Australorp	Geo. Davey & Sons ...	209
141	139	do.	N. T. Wilkinson	202
142	141	do.	do. do. . ..	218
143	142	do.	do. do.	203
144	143	do.	do. do.	200
145	146	do.	A. Wilkinson	245
146	148	do.	do. do.	239
147	149	do.	do. do.	222
148	151	do.	A. R. Caporn	220
149	153	do.	do.	226
150	155	do.	do.	226
151	156	do.	do.	246
152	157	do.	W. G. Hall	214
153	158	do.	do.	262
154	163	do.	M. Wall	248
155	166	do.	do.	239
156	168	do.	do.	210
157	134	Rhode Island Red ..	S. Dolman	206
158	141	do. do. ...	F. Landquist & Son ...	210

In the above trial 78 birds qualified for copper rings, a percentage of 26.5 per cent.

Comparisons with previous years are as follow:—

	1936–37.	1937–38.	1938–39.
Number of Copper Rings awarded	69	75	78
	27·5%	30%	26·5%

The champion team was a pen of Australs entered by Wyndella Poultry Farm, Armadale.

The total of 1,275 first grade eggs was 213 eggs lower than the winner of 1937-38.

Mrs. E. E. Price, of Hilton Park, via Fremantle, won in the White Leghorn section. The team laid 1,261 first grade eggs, this being 4 in advance of the winner of 1937-38.

In the Rhode Island Red section F. Landquist & Son, of Talbot, via York, won with a team which laid 964 first grade eggs.

Bird No. 4 owned by Mrs. E. Kerr, of Wagin, laid a sequence of 167 eggs, but for official records she is only credited with 97. The laying was 69 two-ounce eggs, then one of 1 9/10th ounces, following with 97 two-ounce eggs.

FEEDING.

In addition to the trial birds being tested at the College, the Poultry Branch of the College were testing breeders for their own use and therefore the feed used at the trials must be considered as having been fed to 271 birds in 1936-37 and 248 birds in 1937-38 and 324 birds in 1938-39.

Feed Consumed:

	1936–37.	1937–38.	1938–39.
Wheat	190½ bushels	165½ bushels	224¾ bushels
Pollard	186 bushels	191 bushels	227¹ bushels
Wheat Meal	6,798 lbs.	6,469 lbs.	8,438 lbs.
Meat Meal	1,700 lbs.	1,962 lbs.	2,870 lbs.
Bran	207 bushels	178 bushels	244 bushels
Bonemeal	747 lbs.	990 lbs.	932 lbs.
	5·14 oz. per fowl per day.	5·13 oz. per fowl per day.	5·16 oz. per fowl per day.

The cost of feeding for the 48 weeks in the 1938-39 trial was £110 13s. 6d., or equal to 6s. 10d. per bird, while the net average return for eggs was 18s. 6d. The average profit was 11s. 8d. per bird.

Comparison:

	1936–37.	1937–38.	1938–39.
	s. d.	s. d.	s. d.
Cost of Feed	9 9¼	10 3	6 10
Average Gross Profit	8 10	9 2¼	11 8

Note: Feeding costs are based on the retail prices of all goods as charged by metropolitan produce merchants whilst the returns for eggs are those received in open sales less 5 per cent. selling commission and a deduction of an account sales fee of 6d. per day (a sum equal to £2 12s. per annum).

M. T. PADBURY TROPHY COMPETITION.

I. THOMAS,
Superintendent of Wheat Farming.

With the finalising of the 1938-39 results, only one season remains before this competition closes. Inaugurated in 1930 and organised by the Royal Agricultura' Society, this competition was made possible by a generous donation by Mr. M. T. Padbury, a pioneer farmer of the Moora district.

The trophy takes the form of a handsome shield, a replica of which is presented to the winner of each year's competition. The final award will be made on completion of the 1939-40 results to the competitor gaining the highest average yield per acre per inch of rainfall during the conventional growing period (May to October) for any five years during the period of the competition.

The winner of the 1938-39 competition was Hon. T. Moore of Indarra, with a splendid average of 4 bushels 9 lbs. over an area of 261 acres—this average has only twice been exceeded; by two competitors in 1934 with average yields of 4 bushels 29 lbs. and 4 bushels 13 lbs. He was followed by Mr. E. W. Prowse of Doodlakine with 2 bushels 42 lbs., and Mr. F. C. West of Toompup—the winner in 1936—with 2 bushels 36 lbs.

The conditions under which the competition is conducted are as follow:—

1. The competition will commence with the 1930-31 harvest and continue for a period of 10 years. At the end of that period the trophy will be awarded to the competitor who has taken part in the competition for at least five years, and who obtains the greatest mean average acre yield per inch of rainfall during the conventional growing period. The mean average yield will be computed from the results of the five seasons in which the competitor produced the highest acre-yield per inch of rainfall during the growing period. In the event of a tie the competition will continue between the leading competitors until an advantage is gained by one of them.

2. The conventional growing period for any year will be that decided upon and announced by the Royal Agricultural Society. For the first year, and until further notice, it was decided that it would be from 1st May to 31st October, inclusive.

3. Until the end of the competition the trophy will be in the custody of the Royal Agricultural Society, and will be displayed at any agricultural exhibition held by that society.

4. Each year the competitor who obtains the best average acre yield per inch of rainfall during the conventional growing period will be awarded a replica of the trophy. His name will also be inscribed upon a small shield affixed to the trophy.

5. The rainfall upon which the award will be made will be determined by the Commonwealth Meteorologist from the district records, and his decision in this matter will be final.

6. The competition will be limited to those farmers who harvest at least 200 acres of wheat for grain. Where a competitor is financially interested in the crops grown on one or more farms, he will be required to supply details regarding the production and marketing of the crops on same, and, though usually the award will be made upon the results from the farm nominated by the competitor, the Royal Agricultural Society may require that the crops on these farms be included in the competing area.

7. The average yield will be ascertained from the total area—including self-sown crops—harvested for grain, and determined from the actual amount of wheat sold, as shown by the delivery dockets, plus the amount retained for seed, for home use or for any other purpose.

8. The method of judging will be as follows:—At a convenient time the area harvested for grain will be measured and the quantity of wheat on hand ascertained. On or before 31st January the farmer will be required to furnish the judge with a sworn declaration as to the quantity of wheat sold from the competing holding or holdings, and the amount retained for seed and other purposes; the statement regarding the amount sold to be supported by agents' dockets. The judge, after satisfying himself as to the correctness of this statement, will compute the average yield per acre per inch of rainfall during the growing period from the information received.

9. The judge will be appointed by the Under Secretary for Agriculture and his decision will be final.

10. Nominations for this competition will be received by the Royal Agricultural Society up to the 31st October each year.

The results for last season (1938-39) are given in the table below:—

M. T. PADBURY TROPHY COMPETITION, 1938-39.

Competitor.	Address.	Rainfall during Growing Period.	Area Harvested	Yield. Gross.		Average per Acre.		Average per inch Growing Period Rain.	
		points	acres.	bus.	lbs.	bus.	lbs.	bus.	lbs.
Moore, Hon. T.	Indarra	576	261	6,239	43	23	54	4	9
Prowse, E. W.	Doodlakine	586	543	8,618	58	15	52	2	42
West, F. C.	Toompup	1,020	200	5,281	15	26	24	2	35
Scadding, N. A.	Kulin	671	530	7,822	54	14	45	2	12
Barr, D. F.	Shackleton	846	612	10,673	52	17	26	2	4
Bremner, J. R. & Sons	Corrigin ..	821	882	13,821	36	15	40	1	54

The average yield per acre of the six entrants was 17 bushels 19 lbs., and the average yield per inch of rainfall during the growing period was 2 bushels 18 lbs.

CULTURAL DETAILS.

The winning crop entered by the Hon. T. Moore, of Indarra, was grown on land originally carrying York gum and jam, and was cleared in 1926. The 261 acres cropped were ploughed with a disc cultivating plough to a depth of 3 inches during July and August and cultivated with a springtyne cultivator in September and again in April.

The crop was seeded during May using a combined cultivator drill at the rate of 45 lbs. graded and pickled seed with 100 lbs. superphosphate per acre. Areas and varieties in the competition crop were Merredin 120 acres, Ranee 75 acres, Dundee 66 acres.

Of the 543 acres entered by Mr. E. W. Prowse, of Doodlakine, 29 acres were sown to Centenary, 107 acres to Noongaar, 177 acres to Totadgin, 40 acres to Bencubbin, and 190 acres to Gluclub. The land originally carried salmon gum, gimlet and mallee and was cleared over 15 years ago. It was scarified in July to a depth of 3 inches and again in September and October. During March and April the land was cultivated and seeding commenced in May. The rate of seeding was 40 lbs. per acre with an application of 90 lbs. of superphosphate. The combined cultivator drill was used for planting operations which were completed during May.

Mr. F. C. West's crop at Toompup which gained third place in the competition was grown mainly on old land originally carrying York gum, jam and yate. It was ploughed in June and July with a mouldboard plough to a depth of 2-2½ inches. A portion of the area— 42 acres of new land was disc cultivated during August, the balance being springtyne cultivated during September and October, and again in March and April. Seeding at the rate of 55 lbs. of graded and pickled seed with 130 lbs. of superphosphate was carried out during early June with a combined cultivator drill. The competition area comprised 105 acres of Bencubbin and 95 acres of Free Gallipoli.

Mr. N. A. Scadding, of Kulin, had an area of 530 acres which included Gluclub (160 acres), Bencubbin (230 acres), Totadgin (60 acres), and Pusa (80 acres). The area consisted mainly of old land, 90 acres however were cleared in 1937. It originally carried blackbutt, morrel and salmon gum, and was ploughed to a depth of 3 inches with a disc plough in June and July. Further cultivation was given with a springtyne implement in September and October and again in April. During May, seeding was carried out at the rate of 60 lbs. seed and 120 lbs. superphosphate per acre, using a combined cultivator drill.

The crop exhibited by Mr. D. F. Barr, of Shackleton, consisted of 300 acres of Bencubbin, 200 acres of Gluclub, and 112 acres of Noongaar. It was grown on land cleared in 1925-26 and originally carrying salmon gum, gimlet and morrel. Ploughed 4½ inches deep in June and July with a mouldboard plough, the land was subsequently cultivated in August and again before seeding. During April and May the area was seeded with 45 lbs. graded and pickled seed with 90 lbs. superphosphate per acre.

Messrs. J. R. Bremner & Sons' crop was grown on old land from which salmon gum, gimlet, jam and mallee timber had been cleared. It was worked in June and July to a depth of 3 inches with a rigid tyne scarifier. The scarifier was used again in August, followed by a springtyne cultivator in September and April. The whole area of 882 acres was sown with Bencubbin seeded during April and May at the rate of 50 lbs. seed with 145 lbs. superphosphate per acre with a combined cultivator drill.

In the table below are given particulars of those competitors who have taken part in the competition for four years and who are, therefore, eligible to compete for the final award to be made at the completion of the 1939-40 harvest.

M. T PADBURY TROPHY RESULTS, 1930-1938 (INCLUSIVE).

Competitors who have Competed for four or more years.

Competitor.	Address.	Average Yield per inch of Growing Period Rainfall.																	
		1930.		1931.		1932.		1933		1934		1935.		1936		1937.		1938.	
		bus	lb.	bus	lb.	bus.	lb	bus.	lb.	bus	lb.	bus.	lb.	bus	lb.	bus.	lb.	bus.	lb.
Allen Bros.	East Kumminin	2	11	2	23			2	26	3	1			..					
Atkins, F. M. & J. L.	Jouerdine	2	41	3	0			3	39	4	29			..					
Barnett L. T. C	Walgoolan	2	48	2	19	2	34	2	58										
Barr, D. F.	Shackleton	1	19											1	54	2	17	2	4
Bremner, J. R. & Sons	Corrigin	1	55	2	10	1	48	2	32	2	37	2	12	1	19	2	13	1	54
Creagh Bros., Ltd.	Nungarin	2	20	2	16	1	43	2	12	2	41					2	7*		
Horsman H. & Sons	Bilbarin	1	53	2	6	1	5	2	40					..					
Manuel, C. J.	Mukinbudin	2	44	2	10	2	5	2	5	3	4			...					
Moore, Hon. T.	Indarra			2	47	2	33	3	5			4	6			3	2	4	9
Nottage, R. B.	Tammin			2	36	2	21	3	23	4	13								
Prowse, E. W.	Doodlakine	1	42			1	31			3	13							2	42
Scadding, N. A	Kulin					2	4	2	10	2	49	2	27	1	35			2	12
Stewart, W B.	Gnowangerup	1	52	2	37	1	54	2	55	2	30								
Strange, P. A	Yarding	2	36	2	6			2	48	2	33			1	48				
White, R H.	Gnowangerup	1	51	2	45			2	40	2	47	2	25						

THE PREPARATION OF THE SEED BED FOR WHEAT SOWING UNDER NORTH-EASTERN WHEAT BELT CONDITIONS.

W. M. NUNN, B.Sc., Agric.,
Agricultural Adviser.

From observations made during the judging of fallow competitions and from discussions with farmers of the North-Eastern Wheat Belt over several years, it appears that many wheat-growers in these areas—and probably also in others—do not recognise an objective to the workings they give the fallow. Land is fallowed and the fallow is cultivated for many reasons. To allow better soakage and conserve moisture, to kill weeds and protect the crop from disease, and to encourage the bacteria which prepare nitrates for use by the crop are benefits which are easily obtained by breaking up the surface soil and aerating it. But an equally important objective is the preparation of a suitable seed bed which will be in readiness for planting when the correct time and conditions arrive.

When a wheat grain germinates, it first of all sends out temporary rootlets from the grain itself and a shoot to the surface. On these temporary rootlets and on the food material stored within the grain, the young plant lives until several leaves are formed above ground. Then—and not until then—it thrusts out its permanent root system, and this system is always developed from the stem at a point about 1½ inches below the surface of the soil where the plant emerges.

If the seed has been placed at a depth of, say, 3 inches, then it would mean that the plant has had to provide energy and growth—which could have been avoided by shallower planting—in growing first to the surface and then in thrusting its permanent roots downward again through two inches of soil, loosened by seeding operations, to the consolidated region below, from which it is to get its food and water supplies.

The ideal depth to seed is therefore at 2 inches—a little deeper than the 1½ inches mentioned above—because we have to allow for some settling down with the rains.

But whether you seed deep or whether you seed shallow it is even more important that the seed should be placed on a firmly consolidated seed bed. It is when the roots have to grope around in loose material before obtaining a hold in the firm material below that the plant is rendered susceptible to disease and to drought and, even with favourable conditions prevailing, it suffers a setback which delays its establishment and renders it less hardy throughout its entire existence. When dry conditions are obtained towards the end of the season it is the plant whose roots pass through loose material as a result of improper seed bed preparation which forms whiteheads most readily because, though there may be moisture enough in the subsoil to mature the grain, the upper regions of the roots have dried out with the drying of the loosened surface soil and they are unable to conduct the moisture to the above ground portions of the plant.

The ideal seed bed theretore is a compacted not hard level bed at a depth ot 2 inches.

Very often soil conditions are such that a seed bed of this description is economically unobtainable. Stiff heavy clay soils do not break down readily and in the dry seasons much of the work has to be done while the land is in an unsatisfactory condition for breaking down.

In some cases such a seed bed as has been described may be inadvisable. On hillsides where surface wash is expected with the first rains it is often safer to leave a deeper mulch to ensure rapid soakage, the cultivation following the contours.

Each farmer, however, in preparing his fallow, should aim at the preparation ot a definite seed bed and not at merely breaking up the soil and eliminating the weeds.

How is this objective obtained?

Farmers are now unanimously agreed that the land should be broken up as early as possible in the winter of the fallow year so as to allow the maximum soakage. This is very generally done throughout the lower rainfall wheat areas to a depth of 3-4 inches and it is in subsequent cultivation that methods vary. Naturally, with different classes of soil different methods are required to bring about the same result, but in one important aspect—that of depth we can generalise. If the land has been ploughed 4 inches deep, then the cultivations in spring should be to this depth. A tyne cultivation is preferred at this time of the year as its effect is to comb the soil and sift the fine material downward while the clods are thrown to the surface. This is the first step in the preparation of the seed bed and it will be readily seen that if this cultivation were a shallow one, the machine would ride over the top of much of the cloddy material and subsequent compaction would be very difficult.

The fallow thus enters the summer period with the finer material at the bottom of the ploughed region. Summer rains and the trampling of stock still further compact this layer.

Cultivations after autumn rains and prior to seeding should be to a depth of 2 inches and should be done with a properly adjusted tyne implement which will cut to a level surface. Thus a seed bed is formed above the fine material which was sifted down in the spring cultivation and consolidated throughout the summer. The weight of the implement still further compacts this bed during autumn cultivation.

It has been shown by experiments at the Research Stations and observations elsewhere, that cultivations after summer rains are not economical so long as weed growth can be kept down by grazing. Should a cultivation be given, however, it should be only to a depth of 2 inches so as not to disturb the consolidation taking place below that depth.

The points to be emphasised, therefore, in a generalisation are:—

1. Fallow early.
2. Cultivate in spring with a tyne implement to the *full* depth of the ploughing.
3. Keep weeds down and assist consolidation by grazing.
4. Cultivate after autumn rains and prior to seeding with a properly adjusted tyne implement to a depth of 2 *inches.*
5. At seeding see that the seed and super are planted *on* the seed bed so formed.

SOME FACTORS AFFECTING SEED POTATOES.

E. T. MORGAN,
Officer-in-Charge, Potato Branch.

Western Australia is unique in the fact that practically one variety of potato only is grown throughout the producing areas of the State, namely, the "Delaware." The question which often arises in other countries, where many sorts are usually produced, "Which variety shall I grow?" is therefore seldom asked.

The "Delaware," which was introduced into this State from the United States of America in about the year 1910, has proved itself to be a wonderfully consistent cropper and does well at all times of the year in our varying classes of soil. There is, in my opinion, a great merit in having only one variety, as it is reasonable to suppose that one variety can be maintained in a greater degree of health than is possible in dealing with a large number of varieties. The various virus diseases manifest themselves differently in different varieties, therefore a multiplicity of symptoms would be discernible when many kinds are grown, thereby complicating to a great extent the preservation of even relative freedom from such diseases.

In the past, it has been the common experience of potato growers in nearly all parts of the world that, sooner or later, varieties have degenerated to such an extent that they became unprofitable. It has often been heard that potatoes have "run out," and this degeneration has been greater in some varieties than in others. It is interesting to note that some of the present-day popular varieties were introduced many years ago. For instance, the Brownell's Beauty, which is the favourite variety in Tasmania, was first produced in the year 1873, while our Delaware was produced in America in 1888. Some varieties have been found to have degenerated in a comparatively short space of time.

Following the introduction of the Delaware variety into this State, little trouble in our seed stocks was noted, in spite of the fact that little or no selection was made, and small or "round" seed was mostly used. After a while, many growers, working on the assumption that "like produces like," used large tubers and cut these into sets for planting, and improvement in crops was noted. About 18 years ago, however, it became noticeable that, in spite of this apparent selection, all was not well with our stocks, as various plants in fields showed curly leaves and stunted appearance. Some growers went a step further in

selection and dug out apparently healthy, well-grown plants, saving the tubers for seed purposes, but even then some signs of trouble were still noted. About this period, literature from other parts of the world stated that virus diseases were increasing and mosaic and leaf roll, two types of these diseases, were described.

It was thus possible, with the aid of the Plant Pathologist, for us to begin to assign the reason for the degeneration of stocks. There is, at present, much research work going on in relation to virus troubles and in America many different forms in the potato are recognised. In this State, however, mosaic and leaf roll are mostly in evidence, the first-named manifesting itself in a mottling and crinkling of the foliage, and the latter in a general dwarfing of the plant, with a rolling of the lower leaves, the plant yellowing prematurely, and the yield from these plants being greatly affected.

These diseases live in the sap of plants, and are not arrested by sprays or other treatments which are effective in controlling other diseases in plants. Unfortunately, these virus troubles are transmitted from unhealthy plants by such sucking insects as aphids, thrips, leaf hoppers, etc., to healthy plants. This is the reason why, when the lifting of apparently healthy plants and the tubers from these have been planted, that the succeeding growth has been found to be affected with disease. It will thus be seen that if we are to maintain the productiveness of our stocks, great care in selection is necessary; the only control of these diseases is by the eradication of the diseased plants in our seed plots as early as possible.

In 1926 the Government Certified Seed Potato Scheme was introduced, and by the use of such seed, the virus disease infection has been kept at a minimum. About this period, seed stocks in the South-West were so badly affected that yields in many cases were reduced to 2 tons and less per acre. The introduction of "certified" seed from the Great Southern area, the Denmark, Young's and Kalgan River districts especially, revolutionised the industry in the South-West, and to-day such seed and its near progeny has continued to give excellent crops, our high average of more than 5 tons per acre speaking for itself.

The improvement of the potato by selection is a field of endeavour in which every grower interested in the problem of increased production per acre can engage, but it is practically impossible for the grower to maintain freedom from disease in the commercial plot. This can only be done effectively in a special seed plot which should be well isolated from possible infection from a commercial area, a minimum distance of 200 yards should be allowed from other growing potato plants. The best and only reliable time to establish the seed plot is in the winter, as any virus diseases are more easily determined in colder weather, high temperatures such as are experienced in the summer-grown crop have the effect of somewhat masking these diseases, the symptoms do not show so readily, and greater difficulty is experienced in detecting and eradicating affected plants.

Again, in the colder weather, insects such as aphids and thrips are not so plentiful and the risk of transmission of disease is minimised. This is the reason why, in other countries, it is usual for seed to be purchased from colder parts for planting in warmer areas, such as seed being bought in Scotland for planting in England, and much of the seed in the United States of America, from Canada. In these countries, one main crop per year is planted, while in this State potatoes are grown practically all the year round, and it is thus possible for us to establish seed plots at that time of the year where practice has taught us that best results are obtained.

In the establishment of the potato stud seed plot, it is desirable that the seed shall be taken from apparently healthy, well-grown, true-to-type and heavy-yielding plants, and preferably from the heaviest type of land in our swamp or

summer land. These plants could be staked or marked in some way during the growing season, avoiding, if possible, the staking of any plants in the near vicinity of any other showing mottling or crinkling of the foliage and dwarfed and leaf rolled plants. It is good practice to keep the tubers from each root separate, these can then be planted separately in the seed plot, allowing a small space between each planted root of tubers, so that any plants which may have picked up infection in the growing stage will be together, and eradication of the whole series of roots carried out. A further and more elaborate method that can be adopted in the seed bed is what is known as the tuber unit system. Selection is made as quoted, but instead of each root being separated, each tuber is treated as a separate unit. Each potato is cut into sets, if large enough for cutting, and the sets from each tuber are planted consecutively, allowing a double spacing between this unit and the next, and so on, until the seed bed is planted.

This latter method has been introduced in connection with the certified seed scheme, the first plot being planted in the Denmark area in August, 1937. In this area, such a procedure as a measure for good seed production, is a practicable proposition because only quite small areas are grown in this so-called winter planting. It is usual to employ planting boxes when sowing the crop, so that the sectioning of such planting boxes is easy. A half fruit case (flat) can be divided into six sections, and a kerosene case cut through on the side can be divided into 12 sections. It is thus possible to cut a tuber into each section and planting can be carried out with little loss of time.

The tubers from this crop, after effective "rogueing," are again sown in about March (autumn planting), which crop is harvested in July and August, and this provides seed for the main swamp crop planting in November and December and harvested in March and April, and which supplies certified seed, available for main crop planting in the South-West areas during June, July, and August.

This method allows us, in the case of any of the plants in any unit being affected with disease, to wipe out the whole of such unit. It is desirable to wipe out any unit that shows even one plant to be affected, as it is possible that part of a tuber may be badly affected and easily recognisable, whereas other parts of the same tuber may be affected in a lesser degree, and be not easily discernible, so that by the eradication of each complete unit we shall stand a reasonable chance of obtaining disease-free stocks. By this method badly affected stocks have been cleaned up in a short time.

It may seem strange that one part of a tuber can be affected more so than another, but, according to research work done in various parts of the world on the transmission from diseased to healthy plants, it appears that something like 18 days must elapse before disease reaches the tubers after the inoculation of the plant. It will thus be seen that progress is slow and explains why some tubers or even part of a tuber on the same root are effected, while others appear to remain healthy. The crop may come to maturity and be harvested prior to all tubers becoming affected. Once we have obtained good seed, it is possible, with care and attention, to keep it productive over a number of years, especially if we can grow under sufficiently isolated conditions, so as to avoid contamination from other crops that may be diseased. It is practically impossible to keep our seed perfect, but if a grower takes all precautions he has a reasonable chance of maintaining it at a high degree of freedom from these virus diseases.

Another problem we are faced with in our seed tubers in summer-grown crops is so-called "thready eye," or "spindle sprout." This shows itself in the failure of the tuber to produce a normal shoot, but a thin thread-like growth is sent out from the eye and, when the potato is planted, this weak shoot seldom

emerges above the ground. This trouble has been found to occur in tubers grown mostly in the light sandy peat swamps in the Albany and other coastal districts. Unfortunately, no symptoms are noticeable in the growing plants, and it is often found in the larger tubers from well-grown plants.

No special work has been done in this State on this trouble, but observation tends to the belief that this result is brought about by lightness of soil and high temperatures during the time when the crops are coming to maturity. This observation is strengthened by the fact that the larger tubers are generally affected, while little is noted in the smaller potatoes. It is usual for the larger tubers, in any potato crop, to be found near the surface, and these would be more affected by heated conditions, while the smaller tubers generally found lower down on the same roots, being often in moister soil, are not so affected and little trouble is noted.

It would therefore appear that heated conditions at some stage of the growing period impair the vegetative vigour of the seed tuber for future planting, for it has been noted that where heavy crops of greenstuff have been ploughed in, so increasing the humus content of the soil, thereby minimising extreme difference of soil temperature, that this trouble has been very considerably reduced. This ploughing-in of green crops is, therefore, advocated in an attempt to control this trouble.

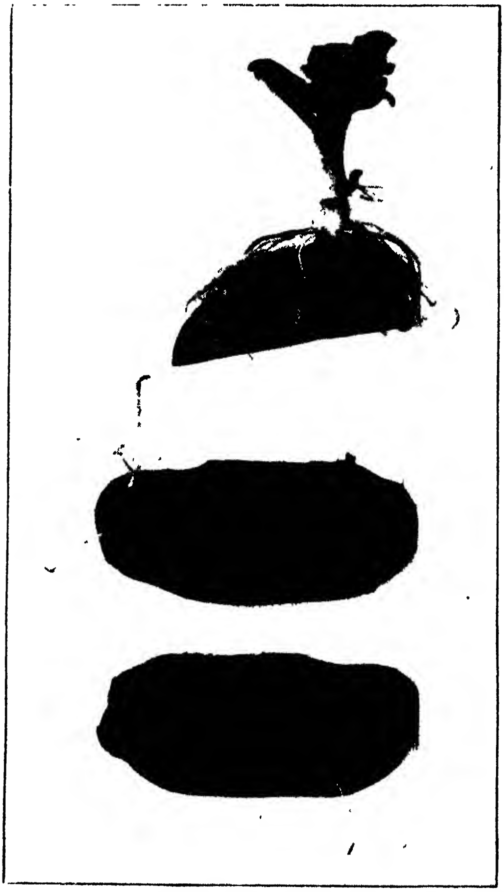
Experimental work in the production of seed in the southerly parts of America where temperatures are high, have demonstrated that a mulch of straw or other litter was found effective in increasing the vigour of the seed, which again tends to show that seed is obviously affected by extreme heat. Whilst this is practicable in a small seed plot, it would be difficult on a large area.

The following photograph shows tubers which were taken by myself from a single plant and planted with results as shown. The "sets" from the large tuber show "thready eye" sprouts, while the other shows a large, healthy, sturdy shoot. I am not forgetting the possibility of virus disease in such a case, but this appears rather improbable on account of the fact that I can instance that seed from the same plot has been planted on different locations with the result that from one soil type so-called "thready eye" has shown prominently whereas in the other case no such trouble has occurred. Seldom, if ever, do we find this trouble from tubers grown in heavy soil types when the crop comes to maturity under reasonably cool weather conditions.

As well as thready eye, a certain lack of vigour in seed which has been produced in light soil types has been noted. Such, when grown alongside seed which has been produced in heavy soils, has failed to give corresponding crops and yields have shown 1 to 2 tons per acre in favour of the heavy soil type seed. When this unthrifty seed is again grown in heavy soils, if free of leaf roll and mosaic, a pick-up in vigour is noticeable. This weakness may be bound up in lack of certain nutrients required by the plant and tubers, and it was suggested to me early in 1937 by an officer of this Department, that copper may be needed in order to build up the vigour of the seed. Recent experimental work in the Albany area in conjunction with the Plant Nutrition Officer (Dr. L. J. H. Teakle) and observations have tended to support this theory.

It has been stated by many growers that the use of immature seed results in heavier yields, but it is hard to understand why, when seed of almost any other plot should be fully developed, the potato tuber should be treated differently. Experiments conducted in various parts of the world have, however, indicated that the planting of immature seed has been attended by heavier yields, while other experimental work has shown that no advantage has been gained by its use. Advocates of immature seed aver that for the production, the proper

water and nitrogen contents of the tubers are obtained just about the time the tops show the first signs of ripening. The evidence in favour of unripe seed is so strong that one cannot lightly disregard it, but recent work has shown that a crop lifted in an immature state is not so long exposed to virus disease infection as is one which is allowed to ripen completely. It may be stated, therefore, that the one important advantage of using immature seed may be due to comparative freedom from transmitted diseases and that evidence points to the immature seed being less vigorous than ripe seed when diseases are absent. It will also be readily appreciated that the storage of seed, which has to be done for some considerable period in the Great Southern areas, will be more successful when the tubers are well ripened before being harvested.



"Sets" from tubers from a single plant. One "set" is showing a normal "shoot" and the other two show thready eye sprouts

It has been discovered that where black spot or "early blight" makes its appearance in the potato tops, as it often does in autumn-grown seed crops, if the tubers are dug on the green side so-called storage trouble develops, but where the potatoes are thoroughly ripe when harvested, little damage ensues during storage.

(To be continued.)

PASTURE SPECIES TRIALS.

H. G. ELLIOTT, Agrostologist.

The State Committee of the Australian Dairy Produce Board Pasture Improvement Committee (W.A.), during 1937, made further funds available to be used for initiating demonstrations under dry land conditions with a view to showing the value of various grass species under controlled methods of grazing.

The State Committee decided, as in the case of the initial experiments being conducted under irrigated conditions on the properties of Messrs. A. E. Jackson, of Roelands, J. Neil, of Waroona, and C. H. Henning, of Hamel, to co-operate with the Department of Agriculture in establishing two further experimental areas on the properties of Mr. A. A. Millar, of Forest Grove, and the Denmark Research Station.

1.—DENMARK RESEARCH STATION.

The area of 10 acres, when taken over in May, 1937, was mainly under subterranean clover and annual grass species such as brome, spear, silver and barley grasses, and in odd patches *Paspalum dilatatum*. By June, 1937, the complete area was ready for sowing, and on the 17th of that month all species were sown.

Cultivation.—The land was first ploughed to a depth of about 4in. and allowed to remain in fallow for approximately three weeks; it was then re-ploughed and worked down thoroughly with a cultivator so that a firm seed bed was formed. The area of 10 acres was divided into five fields, each field being two acres in extent.

The objects of the experiment included—

(1) To determine the most suitable grass for the establishment of a permanent pasture under dry land conditions on the soil type selected in this area.

(2) The collection of information regarding the carrying capacity of these grasses on small areas.

(3) To determine the best method of managing to incorporate grass species.

Soil.—Practically all the soil on Plots 1, 2, and 3 consisted of loamy sand and some brown gravelly sand, while on Plots 4 and 5 the soil type consisted mainly of sandy grey and brown gravels, together with some sand and loamy sand soil types. The area on Fields Nos. 1, 2, and 3 had a tendency to become water-logged in the winter. The original timber consisted of jarrah and red gum, and the whole area on Fields 1, 2, and 3 was heavily infested with bracken fern. During the winter of 1937 some drainage was carried out to relieve surplus water on Fields 1, 2, and 3.

Seed Mixtures.—The seed mixtures sown during mid-June were as follows:—

Field No. 1—South Australian Certified *Phalaris tuberosa*—4 lbs. per acre.

Field No. 2—Victorian Certified Clunes Perennial Rye Grass—8 lbs. per acre.

Field No. 3—New Zealand Yorkshire Fog—4 lbs. per acre.

Field No. 4—New Zealand Certified Italian Rye Grass—8 lbs. per acre.

Field No. 5—New Zealand Commercial Perennial Rye Grass—8 lbs. per acre.

The whole area, prior to cultivation, had been growing the mid-season variety of subterranean clover. With Fields Nos. 4 and 5, however, a very heavy cover of annual grasses occurred, as this area was much older than that of the other three fields.

Fertiliser.—Two hundredweight of superphosphate and ammonia No. 3 per acre was applied at the time of planting. A further 1 cwt. per acre was applied during late September (1937), giving a total of 3 cwt. per acre over the complete area for the first season. The fertilising rates for 1938 consisted of 2 cwt. of superphosphate in the autumn, plus 1 cwt. in the spring. A further application of 2 cwt. per acre has been given during May, 1939.

Germination.—Generally the germination of the grass species on fields was good. Owing to the late planting, however, very little clover grew over the area for the first year. After the early autumn rains in 1938, excellent growth of subterranean clover occurred on all fields. The *Phalaris tuberosa* in Field No. 1 gave exceptionally good germination, and showed vigorous growth in the early part of the season. With the Clunes perennial ryegrass, however, which was sown in Field No. 2, the germination was satisfactory, but there was practically no clover growth. The Yorkshire fog in Field No. 3 gave a very high percentage of germination, and by September had given practically a full ground cover, the plants all being very vigorous. In Field No. 4 the Italian ryegrass gave a reasonable germination, but was suppressed to a great extent by the heavy growth of minor annual grasses which had grown very vigorously during the spring months. Owing to the unpalatability of these annual species during the time they are flowering, very little control by grazing could be obtained, and the complete area in Fields Nos. 4 and 5 had to be mown in an attempt to reduce the stand of these grasses. The same condition as given for Field No. 4 prevailed for Field No. 5, commercial perennial ryegrass.

Bracken Fern.—To assist in controlling this fern, the complete area on Fields Nos. 1, 2 and 3 was mown in September, 1937. This was again carried out in March, 1938.

Grazing.—The grazing obtained from all fields during the first season was practically equal, being 22 grazing days of 8 hours per month per acre with dairy cows.

CONDITION OF FIELDS—1938.

Field No. 1.—During the year, the *Phalaris tuberosa* became fairly well established, with the crowns of the plants greatly increasing in diameter, and owing to the vigorous growth of clover which occurred during the season, the leaves of the *Phalaris* showed good colour, and the plants were generally vigorous. During the winter, however, the plants had a tendency to show yellowness on the tips of the leaves, this being attributed to the excess wetness of the ground during that time.

Field No. 2.—Clunes perennial ryegrass—Generally the plants were vigorous and showed a healthy green colour. Owing, however, to the extremely dry summer which occurred, there was a tendency for the ground cover over the area to be patchy.

Field No. 3.—Yorkshire fog—On the sandy and sandy-loam types of country it is well established, but on the more gravelly soil there was a tendency for a number of the plants to die out during the first summer.

Field No. 4.—The Italian ryegrass practically disappeared after the first season, and at the end of 1938 only a few scattered plants could be observed throughout the field.

Field No. 5.—The Commercial ryegrass in this field has practically gone out. Only in isolated places can any of the plants be found.

General.—Owing to the heavy rainfall of 7½ inches which occurred in January, 1939, the subterranean clover germinated freely on all fields, and the following

dry spell killed back the majority of the plants. The *Paspalum dilatatum* is gradually increasing over all plots, more particularly on the lower end of Fields Nos. 4 and 5. The complete area was mown in January, 1939, to again assist in controlling the bracken fern. The grazing obtained for 1938 was as follows:—

Field No. 1—135 grazing days per acre.
Field No. 2—122½ grazing days per acre.
Field No. 3—154½ grazing days per acre.
Field No. 4—183 grazing days per acre.
Field No. 5—135 grazing days per acre.

In January, 1939, it was decided to completely clear all the standing timber off Fields Nos. 3, 4 and 5. This operation has now been completed.

2.—A. A. MILLAR, FOREST GROVE.

As was the case with the Denmark Research Station, 10 acres of land was selected and divided into 5 2-acre fields. The area was taken over in April, 1937. Prior to the establishment of the species in this area, the pasture consisted mainly of subterranean clover, drooping flowered clover and minor annual grasses. By May, 1937, the complete area was ready for sowing and early in June, 1937, all species were sown.

Soil.—The soil consisted of red karri loam, which was previously timbered with karri and red gum. It was first partially cleared in 1925, and after a few years under subterranean clover, was cropped with maize. This crop was followed with oats and peas.

Cultivation.—The first ploughing was delayed to allow the weed and existing pasture seeds to germinate. These were ploughed in and the land well worked down prior to sowing.

The objects of the experiment were the same as those given for the Denmark Research Station.

Condition.—By the end of June, all species were showing an excellent germination, with the exception of Yorkshire Fog, which was a little slower than the other species. The ground, however, was very wet, due to the exceptionally heavy rains in the earlier part of the season, *i.e.*, 24 in. in three months. However, there was no surface water showing on the ground, which was, nevertheless, in a soggy condition.

Seed Mixtures.—The following seed mixtures were sown:—

Field No. 1—Commercial Perennial Ryegrass—6 lbs. per acre.
Field No. 2—New Zealand Yorkshire Fog—4 lbs. per acre.
Field No. 3—New Zealand Italian Ryegrass—8 lbs. per acre.
Field No. 4—South Australian Certified *Phalaris tuberosa*—4 lbs. per acre.
Field No. 5—Victorian Certified Clunes Perennial Ryegrass—8 lbs. per acre.

Fertilizer.—2 cwt. of superphosphate and ammonia No. 3 was applied at the time of planting. A further 1½ cwt. of superphosphate was applied in the early spring. The fertilizer rate for 1938 consisted of 2 cwt. of superphosphate in the autumn plus 1 cwt. in the spring. A further application of 2 cwt. per acre has been given in April, 1939.

Germination.—Generally the germination over all plots was good. Owing to the late ploughing, however, very little clover established itself during the first year. Unfortunately a fair amount of cape-weed grew and, more or less, took charge of the complete area in the earlier stages. The cutting or grazing off could not be carried out owing to the softness of the ground. This weed infestation affected the ultimate stand considerably.

The following table gives the cow grazing days (8 hours) per acre for each field for the year 1938:—

Field No. 1—Commercial Perennial Ryegrass ..	25.8 grazing days
Field No. 2—N.Z. Yorkshire Fog	14.5 ,, ,,
Field No. 3—N.Z. Italian Ryegrass	17.0 ,, ,,
Field No. 4—South Australian *Phalaris tuberosa*	28.0 ,, ,,
Field No. 5—Vict. Clunes Perenial Ryegrass	31.6 ,, ,,

General.—The *Phalaris tuberosa* on Field No. 4 showed a decided improvement in vigour and development of plants over the initial year, 1937. Clunes Victorian Perennial Ryegrass is now well established and is far superior to the Commercial and Italian Ryegrass fields. Subterranean and Drooping Flowered clovers have re-established themselves over all fields and gave good growth during 1938.

To Mr. V. E. Randall, Manager Research Station, Denmark, and Mr. J. M. Nelson, Dairy Supervisor, Vasse, I am indebted for obtaining most of the field information given in this article.

THE SOILS OF THE 3,500 FARMS SCHEME AREA, WESTERN AUSTRALIA.

L. J. H. TEAKLE.

Summary.

1. The structure of the 3,500 Farms Scheme of Western Australia, as one of the post-war land settlement schemes in the British Empire, is briefly discussed.

2. The diagnosis of soil salinity as the major contributing cause of abnormally low wheat yields in the Salmon Gums district led to a reconnaissance of the portion of the scheme lying in the triangle which has Salmon Gums, Newdegate and Southern Cross as its apices.

3. A brief description of the general geological, vegetation, climatic and soil factors is given. The climatic factor is suitable for wheat growing and sheep raising, and the woodland and mallee soils, on which the settlement was to be based, were found to belong to the zone of grey and brown solonised soils of the present wheatbelt.

4. Examination of soil samples from 650 sites showed the woodland soils to be affected by a degree of soil salinity unusual in the wheatbelt generally, but comparable with that at Salmon Gums.

5. On the basis of profile features the woodland soil types were segregated into 6 groups and the analyses considered in relation to these groups. It was found that the heavier textured soils were most seriously affected by salinity while the lighter textured types could generally be regarded as "safe."

6. Using the conclusions from later surveys, it is estimated that about one-fifth of the area of woodland soils would be excessively saline for wheat production.

7. If the powdery morrel soils are included with the excessively saline soils, about one-third of the area of woodland soils would be more or less unsuitable for wheat production.

8. It is suggested that, from the soil point of view, agricultural development would be possible in the light of a knowledge of the nature of the soil types of the area and the results of many years of farming experience and agricultural research in the Salmon Gums and other districts.

Introduction.

Perhaps the most ambitious post-war land settlement project in Australia was that popularly known as the 3,500 Farms Scheme, which was suggested by the Western Australian Government and adopted for investigation by the Development and Migration Commission. As part of the rehabilitation programme after the war of 1914-18, the British and Australian Governments entered into an agreement for the absorption of British migrants and their establishment on the land with the object of more suitable adjustment of primary and secondary industries and appropriate distribution of population within the Empire as an economic unit. In 1922 the British Parliament passed the Empire Settlement Act which empowered the Secretary of State to formulate and carry out schemes, in association with Dominion Governments and other authorities, for settlement in overseas Dominions of suitable people in the United Kingdom. This Act is to run until 1952. Under it, the Secretary of State entered into an agreement with the Commonwealth of Australia in April, 1925, for the spending of £34,000,000 of British loan money to initiate settlement and to improve facilities in settled areas, and so promote development and expansion. Working conditions were established and were largely directed to the absorption of migrants.

The following year the Commonwealth Parliament passed the Development and Migration Act of July 21, 1926, to implement the agreement with the British Government. Under this Act four Commissioners, headed by Sir H. W. Gepp, were appointed with wide powers and functions and, among other responsibilities, were charged with the thorough investigation of all schemes submitted by the States under the Migration Agreement. This Board was critical, yet constructive, and made every use of expert advice in the consideration of projects placed before it. They required the best factual basis for all propositions and lent every assistance in the collection of data necessary for the proper evaluation of all schemes submitted. From their reports may be obtained information concerning the various projects for development brought under the notice of the Commission and it is some consolation that the Western Australian 3,500 Farms Scheme was not the only one failing to meet with final approval.

The 3,500 Farms Scheme.

Practically the only large area of wheat lands in a suitable climatic zone not then settled in Australia, was in this State and lay—

(a) South of Southern Cross and between Newdegate and Salmon Gums.

(b) North of the Lake Brown loop railway and east of the southern portion of the Wongan Hills-Mullewa railway.

It was estimated that the first section, covering about 7,000,000 acres between Newdegate and Salmon Gums constituted seven-eighths of the total area available and would be most suitable for the opening up of the scheme. (The location of this area is shown on the map in Fig. 1.) Consequently, the land was rapidly classified by surveyors, largely on the basis of vegetation types which had proved generally satisfactory in other parts of the wheatbelt, and subdivision into blocks suitable for wheat and sheep farming commenced. It was expected that about 3,000 farming units, based on the first-class land available, were possible in the area and that 1,000,000 sheep would be carried in addition to cropping 1,000,000 acres to wheat annually. The estimated yield of wheat was 12 bushels per acre. Railways, roads, water supplies, schools, etc., and harbour facilities were to be provided at an estimated cost of over £5,000,000 and a like sum would be required for the settlement of migrants on the individual holdings. The world's markets for wheat and wool appeared to offer splendid prospects and the scheme seemed

economically and socially sound. Of course, the collapse of wheat prices in 1929 was not anticipated by anyone.

The first misgiving arose from a consideration of the wheat returns from the Salmon Gums district which bounded the scheme on the east. This district since 1914 had fairly consistently failed to attain the State average yield per acre and the most unsatisfactory returns had been obtained since 1922 when settlement of

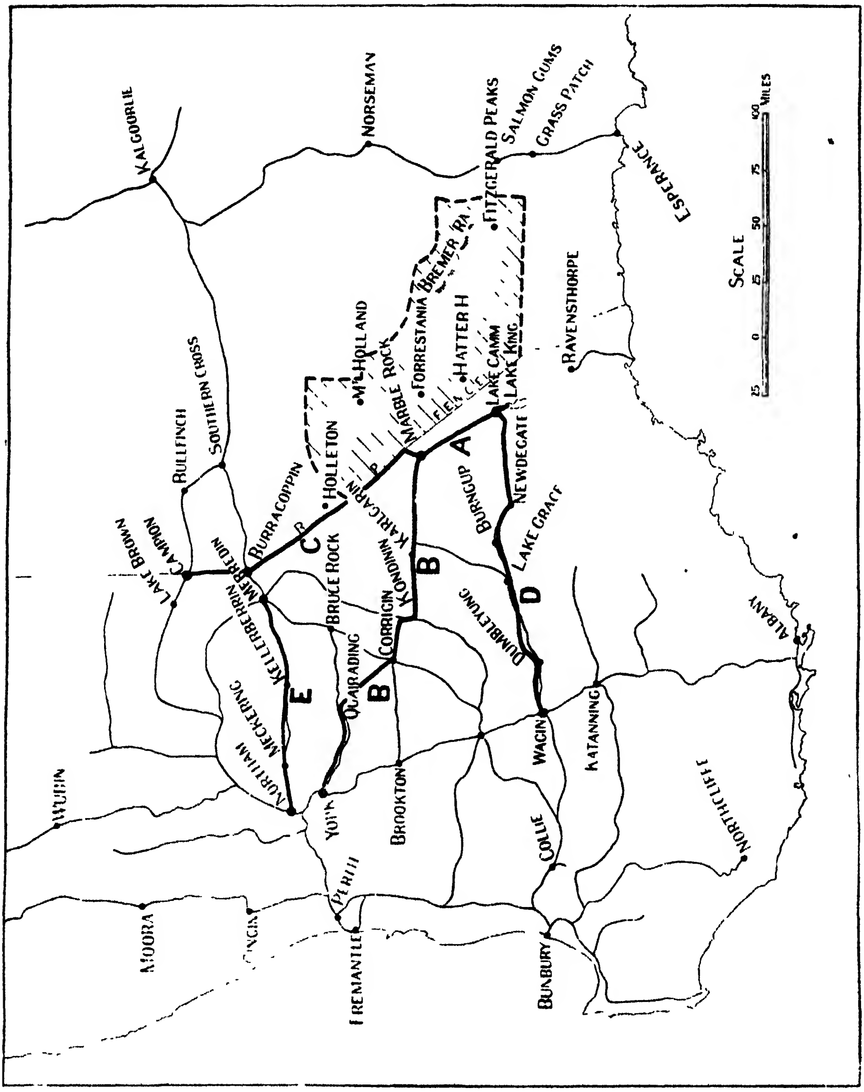


Fig. 1.—Map of south-western portion of Western Australia, showing the location of the portion of the 3,500 Farms Scheme investigated, and of traverses made to ascertain the conditions in the settled parts of the wheatbelt.

the district had begun in earnest. The main reasons advanced, namely, unsatisfactory settlers, "sour" mallee land, and poor methods, failed to satisfy the Commission. A comparison of the yields of wheat per acre for the State and for Salmon Gums is given in Table 1.

TABLE I.

Comparison of Yields of Wheat per acre for the State and the Salmon Gums District, 1914 to 1930.

Year.	Salmon Gums District.	State.
	Bushels per acre.	Bushels per acre.
1914	2·5	1·9
1915	5·3	10·5
1916	9·6	10·3
1917	10·1	7·4
1918	2·9	7·7
1919	6·2	10·8
1920	10·8	9·6
1921	8·3	10·4
1922	6·6	8·9
1923	3·1	4·4
1924	4·0	12·8
1925	4·2	9·7
1926	6·9	12·1
1927	7·8	12·1
1928	3·6	10·1
1929	7·2	11·0
1930	9·5	13·5
Average (1914–1930)	6·4	9·6
Average (1922–1930)	5·9	10·5

It was evident that, if the Salmon Gums area were representative of the unoccupied land to the westward, a 6 bushel average could be expected instead of the estimated 12 bushels on which the scheme was based. The writer was requested in 1929 to investigate the situation at Salmon Gums with a view to ascertaining the cause of the unsatisfactory yields.

Investigation in the Salmon Gums District.

In May, 1929, a visit was paid to the Salmon Gums district. It was observed that the soils of the district fell into three main classes:—

1. Sandy surfaced types with a calcareous clay subsoil.
2. Heavy textured or clay types which were generally characterised by crab-holes or gilgais.
3. "Kopi"* types related to the powdery morrel soils or other districts.

While patches of timber occurred throughout the district (and hence the name Salmon Gums), the prevailing vegetation consisted of stunted eucalypts and mallees associated with tea trees (*Melaleuca* spp.) and a variety of shrubs.

Through the courtesy of the Manager of the local Branch of the Agricultural Bank (Mr. H. F. Rodgers) an inspection of the cropped soils of the district was made. It was found that many instances of crop failures or poor returns were directly correlated with soil salinity. It seems that, in many instances, in which disappointing returns were being obtained, the first crop, often roughly sown on the burn, had been quite good, averaging, perhaps, 5 bags per acre, while subsequent crops, put in under more approved farming conditions, had yielded only as many bushels. The heavy textured "gilgai" country and the "kopi" types were most generally associated with the crop failures and it was evident that the "safe" soils were the sandy-surfaced types.

* Kopi is a native term properly applied to deposits of whitish floury gypsum but, in the Salmon Gums district, it is used popularly for the light grey or whitish calcareous soils of the powdery morrel type.

TABLE 2.

Distribution Table showing the incidence of Soil Salinity in Virgin Country and the Relationship between Soil Salinity and Growth of Crops, Weeds, etc., in the Salmon Gums District, June, 1929.

Depth.	Percentage of Samples in each range of total water soluble salt concentration* expressed as per cent. in dry soil.											
	·05 and below.	·05 to ·10.	·10 to ·20.	·20 to ·30.	·30 to ·40.	·40 to ·50.	·50 to ·60.	·60 to ·70.	·70 to ·80.	·80 to ·90.	·90 to 1·0.	above 1·0.	No. of Samples.
A. Salinity of Soils under virgin conditions.													
Surface†	55	16	6	3	7	10	3	...	...	...	...	...	31
Subsoil	7	4	...	4	4	22	7	19	11	11	7	4	27
B. Bare patches where no crop or weeds have grown on cultivated land.													
Surface†	14	14	28	5	5	5	5	5	...	...	10	9	21
Subsoil	...	5	...	...	10	15	15	20	10	5	10	10	20
C. Areas where some growth of crop, weeds or grass occurred on cultivated land.													
Surface†	41	36	14	4	5	...	...	...	...	...	...	...	22
Subsoil	...	5	10	24	24	9	9	5	9	...	...	5	21

* Determined by the Wheatstone Bridge method of Davis and Bryan (1910). † Generally from a surface layer 4 to 6 inches deep.

The analysis of numerous soil samples taken to represent the various soil conditions established a marked correlation between crop failures and soil salinity. Of course, other factors operated in some instances, but the majority of the cases were due to excessive salinity and this developed principally on the heavy "gilgai" soils and the "kopi" types. From examinations made it was evident that only a thin layer, perhaps 6 inches deep, of salt-free surface soil was necessary to grow some sort of a crop but, following clearing, surface concentration of salts, brought up by capillarity, proved serious in these types in later years.

Table 2 gives a picture of the virgin soils of the Salmon Gums district with respect to salinity and, also, the relation between salinity and crop growth.

From this information it is apparent that soil salinity in the Salmon Gums district is very general in the virgin country but under these conditions the surface is usually quite low in salt content. On certain soil types salt concentration in the surface layers occurs after clearing and cultivation, and this concentration, associated with a highly saline subsoil, is responsible for a considerable proportion of crop failures. In this district, some of the crop failures not due to high salinity, are associated with "kopi" soils which have been found generally unsatisfactory for wheat growing in the drier portions of the district irrespective of salt incidence. Soils on which crops, weeds and grass grow are found to exhibit, in general, a much lower salt content than the less satisfactory sites.

Some details of analyses of individual soil samples from sites representing land which carried fair to good crops and that which carried poor or very poor crops are given in Table 3.

TABLE 3.

Analyses of Soils from Sites representing land which carried fair to good wheat crops and poor and very poor crops.

Fair to Good Crops.				Poor and Very Poor Crops.	
Depth.	T.W.S.S.	Depth.	T.W.S.S.	Depth.	T.W.S.S.
inches.	%	inches.	%	inches.	%
0—3	·04	0—8	·03	0—5	·07
12—14	·41	below 12	·26	18—20	1·1
14—20	·46				
		0—5	·04	0—4	·05
0—3	·04	5—12	·22	4—10	·30
6—12	·32	12—24	·38	10—24	·41
12—18	·47				
		0—6	·13	0—6	·17
0—2	·06	6—12	·16	6—12	·37
2—12	·51				
		0—6	·06	0—9	·38
0—4	·07	6—15	·22	9—18	·63
4—8	·04				
8—24	·66	0—3	·03	0—3	·14
		3—18	·47	3—18	·71
		below 18	·59	18—20	·86

Recognising the number of complete failures associated with excessive soil salinity and the generally high level of salinity associated with the poor and very poor crops in comparison with the fair to good crops, there can be no doubt as to the importance of soil salinity in the Salmon Gums district. This finding confirms

that of Professor J. W. Paterson in his evidence to the Royal Commission on the mallee belt and Esperance lands (1917).

The results are of additional value in pointing to the relative importance of surface and subsoil concentrations in relation to crop growth and form the basis for tentative standards to be used in the interpretation of later results. In later investigations soils were classified as highly saline for wheat growing where the surface contained above 0.20 per cent. and the subsoil above 0.40 per cent. total water soluble salts. The surface soil was generally taken to a depth of from 6 to 12 inches and the subsoil below 12 inches deep.

It is concluded that, when due allowance is made for soil variability and the importance of other factors affecting crop growth, this information establishes the fact that the incidence of soil salinity has been the most important single factor of those contributing to the unusually low wheat yields in the Salmon Gums district.

Another very important factor is the occurrence of the unsatisfactory "kopi" soil, and there is every reason to believe that the avoidance of saline and "kopi" soils would have enabled the Salmon Gums district consistently to approach the State average for wheat yield.

The Reconnaissance of the 3,500 Farms Scheme.

Following the diagnosis of the principal factors responsible for the unsatisfactory wheat yields at Salmon Gums, a reconnaissance was made of that portion of the 3,500 Farms Scheme lying south of Southern Cross and between the Rabbit-proof Fence and Salmon Gums.

During the previous three years some 12 parties from the Department of Lands and Surveys had been in the field and had classified and mapped the land on the basis of vegetation and general soil characters into three main classes:—

First class:—Woodland and mallee country in which a good clayey subsoil occurred within a few inches of the surface.

Second class:—Mallee country associated with sandy soils.

Third class:—Heath and wodjil country associated with sandy and gravelly soils—the so-called sandplains.

The information was compiled on base maps coloured according to land class, and, by a process of reduction, the work was represented on a plan using a scale of 300 chains to the inch. This plan affords a general picture of the whole of the area and, at that time, was the finest piece of land classification attempted in Australia. From it the location of the principal blocks of first class agricultural land for wheat growing and sheep raising purposes were accurately known. As it had been decided to organise the settlement principally on the first class land, it was then possible to plan routes for railways and roads and design holdings on the basis of the base maps prepared. Figure 2 shows by means of a sketch, the general distribution of first class lands throughout the area, and points to the difficulties involved in serving an area in which the recognised potential farming land was so widely scattered. It was estimated that only about three farms per mile of railway line could be surveyed if settlement was confined to the first class lands as had been decided.

As the first class had been adopted as the basis for settlement the investigations were confined largely to the woodland soil types and the heavier types of mallee country as mapped by the Lands Department. Some three trips were made through various portions of the area to study both the soil and ecological conditions. In all, the field work occupied about nine weeks and soil samples, representing largely the first class land, were examined from about 550 miles of traverses through the

area. Over 1,500 samples from 650 sites were analysed and the results interpreted in the light of local evidence from the Salmon Gums district supplemented by experience available from other parts of the world.

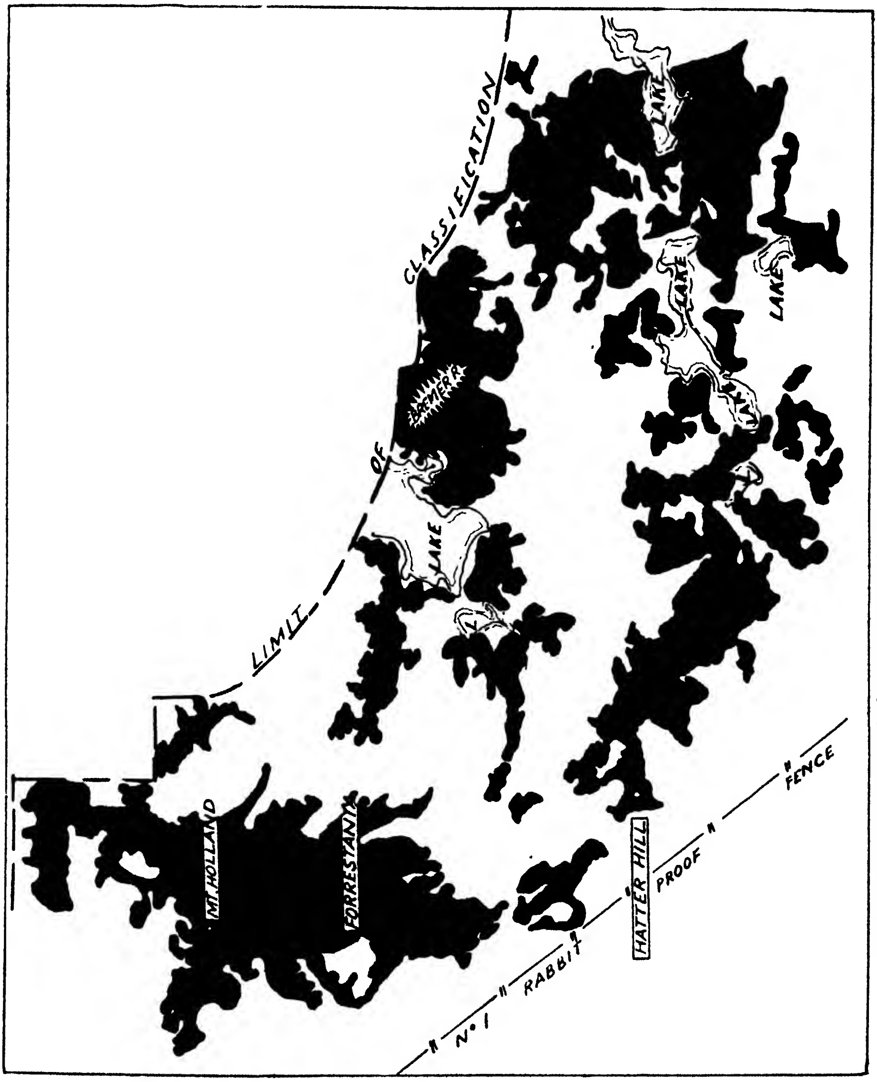


Fig 2.—Sketch map of the portion of the 3,500 Farms Scheme investigated, showing the location of the main areas of "first class" soils

a.—GEOLOGY AND PHYSIOGRAPHY.

The area forms part of the dissected Great Plateau of Western Australia.

In common with the bulk of the Western Australian wheat belt, it may be described as a gently rolling, slightly dissected plain, broken at wide intervals by low hills and ranges of basic intrusives and auriferous rocks and, at the Fitzgerald Peaks, by a high granite boss (Peak Charles, 2,100 feet above sea level). The lower portions of the plain are probably ancient valley formations, formed by dissection of the plain, and are generally 800 to 1,000 feet above sea level. The lowest portions of these valleys are commonly occupied by broad salt "lakes" or salinas (see Fig. 2) and at higher levels are the normal woodland soils—the first class soils of

the land classification. The soils of the higher portions of the plain, generally 1,000 to 1,300 feet above sea level, are characteristically sandy and gravelly in nature. They are not related pedologically to the normal woodland soils but are highly leached and acidic in reaction. Furthermore, they support a heath vegetation and are generally regarded as of low agricultural value. Consequently, they are classified as third class and were not considered in the settlement plan. According to Prescott's (1931) theory, which is now well substantiated, these areas represent the remains of an acient highly leached soil which protect the underlying rocks from soil-forming agencies and the production of "normal" soils for this climatic zone.

Intermediate between the valley woodland soil types and the heath soils of the higher parts of the plain, are the mallee types. These do not occupy a large proportion of the area over the main portion of the scheme and are regarded as second class for agricultural purposes.

The principal underlying rocks are the very ancient Precambrians which include both granitic* and basic auriferous types. The former are more extensive but a considerable proportion of the first class land is associated with the low hills and ranges of auriferous country as at Mount Holland, Forrestania, Bremer Range and Hatter Hill. The granitic rocks underlie both woodland soils in the valleys and sandy and gravelly soils of the sandplain or heath country.

While no geological evidence was obtained, the soil characters indicate that there are also areas of Miocene sediments similar to those recognised in the Salmon Gums district.

(b) VEGETATION.

In outward appearance, the vegetation associations resemble those of the settled portions of the Western Australian wheat belt. Areas of eucalyptus woodlands, strips and small blocks of mallee country and expenses of heath country or sandplain are the principal vegetation groups. However, closer examination and recognition of the species of plants comprising the various associations reveal very important differences. In addition to the well known and widely distributed salmon gum (***Eucalyptus salmonophloia***), gimlet (***E. salubris***), morrel (***E. longicornis***), and yorrel (***E. gracilis***), other species of trees of more restricted habitat are merrit (***E. Flocktoniae***), white barked redwood (***E. oleosa*** var. ***transcontinentalis***), ribbon bark (***E. dumosa***), ***E. calycogona***, ***E. annulata*** and black morrel (***E. melanoxylon***). A wide variety of mallees are recognised, of which ***E. diptera***, and ***E. grossa*** appear to be confined to the region. Other species of more general distribution are ***E. eremophila***, swamp gimlet (***E. spathulata***), ***E. annulata***, ***E. oleosa***, ***E. dumosa***, ***E. calycogona***, ***E. leptophylla***, ***E. cylindriflora***, ***E. gracilis***. ***Melaleuca*** spp. are very common and often form a dense undergrowth. Various ***Eremophila*** spp. are represented throughout the area as also is the genus ***Acacia***. Saltbushes and greybush (***Cratystylis conocephala***), occur in patches while widely occurring species are ***Halgania*** spp., ***Wilsonia humilis***, daisy (***Olearia Muelleri***), rosemary (***O. revoluta***), cherry (***Exocarpus aphylla***), hops (***Dodonea*** spp.), centipede bush (***Templetonia sulcata***), ***Daviesia aphylla*** and spp., camel bush (***Alyxia buxifolia***), ***Boronia xerophila***, quondong (***Santalum acuminatum***), ***Grevillea*** spp., ***Scaevola spinescens***, spinifex (***Triodia*** sp.), ***Bossiaea leptacantha***, etc. The ecological significance of the vegetation associations is very imperfectly understood, but there is no doubt that soil conditions differ here from other portions of the wheat belt and this fact correlates with the number of distinct vegetation associations characteristic of this

* In the absence of geological surveys acidic crystalline rocks of the area are described as granitic. It seems likely, however, that considerable areas of these granitic rocks are related to the Whitestone series which are metamorphic and that the igneous granites are represented by the bosses which outcrop throughout the area but do not cover a very large area. One of the Fitzgerald Peaks, Peak Charles, with a height of 2,100 feet, and which rises about 1,800 feet sheer out of the plain, is an unusual representative of these granitic bosses.

TABLE 4.

Rainfall Records for Centres representing the portion of the 3,500 Farms Scheme Examined and for Merredin to afford a comparison with other Districts of similar rainfall.

Station	Years Recorded to 1937, inclusive.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Salmon Gums ...	16	54	58	130	112	139	146	131	150	102	107	83	76	1,288
Grass Patch ...	32	42	69	97	89	170	166	156	166	130	131	91	77	1,384
Lake King ...	8	50	14	180	74	160	151	176	180	94	132	61	49	1,321
Emu Rock* ...	33	43	34	80	82	139	130	141	158	78	69	67	34	1,055
Southern Cross ...	48	48	58	103	84	139	139	139	119	74	64	49	50	1,066
Merredin ...	34	42	42	99	98	155	200	216	160	107	88	43	55	1,305

* Emu Rock may be taken to represent Lake Carmody and Marble Rock.

(Information supplied by the Commonwealth Meteorologist.)

area. These facts are the basis for the definition of the Fitzgerald soil region by the writer (Teakle 1938).

(c) CLIMATE.

The climate over the bulk of the portion of the 3,500 Farms Scheme examined will closely resemble that of Salmon Gums and Grass Patch and the area will benefit from the influence of the Southern Ocean and a longer growing season. The northern limits of the area, however, are likely to approach Southern Cross conditions climatically and will thus be drier and more hazardous agriculturally from the standpoint of climate.

Rainfall records for Salmon Gums, Grass Patch, Emu Rock (representing Lake Carmody and Marble Rock), Lake King, Merredin and Southern Cross are given in Table 4.

Attention may be drawn to two important characters of the rainfall incidence of these areas—

1. In comparison with the more northern districts represented by Merredin and Southern Cross, the period of generous rainfall (above 100 points per month) extends over a longer period and includes October.
2. The rainfall per wet day is very low but is similar to that for other districts of similar rainfall as shown below:—

Station.	Period	No. of Wet Days.	Rainfall per Wet Day.	Average Annual Rainfall.
			points.	points.
Salmon Gums	1919–1932	76	16·9	1,282
Lake King	1930–1936	81	16·0	1,292
Lake Brown	1915–1936	65	15·8	1,023

The result of the low precipitation per wet day is very restricted leaching which is reflected by lime and salt accumulation in the subsoil, the absence of streams, and a xerophytic vegetation.

The Soils.

The soil conditions of the Fitzgerald region have been briefly described by Teakle (1938), but few details were possible in that paper. The present paper attempts to give a more complete picture of the soils of the main portion of the region which was covered by the reconnaissance.

Primarily, the soils reflect the geological conditions, and soil associations related to the following formations may be recognised:—

1. The sandy and gravelly soils of the lateritic peneplain. These are popularly known as sandplain soils and are of low fertility.

2. The soils of the Miocene sediments.

3. The soils of the Precambrian rocks. The forest soils typical of the Western Australian wheat belt are related to these formations and include the well recognised salmon gum, gimlet and morrel soils.

4. The soils of the basic intrusives and auriferous belts. Heavy textured forest soils form in these hilly areas and carry a more varied range of tree eucalypts than other areas. The high fertility level of these soils must be discounted in low rainfall areas on account of a high water requirement.

As the reconnaissance was designed to determine the incidence of soil salinity in the woodland and better class mallee soils on which agricultural settlement was to be based, attention was practically confined to these types. Furthermore, soil salinity is practically unknown in the sandy and gravelly soils of the sandplains and close investigation of these was, therefore, unwarranted.

It has been established that the woodland and mallee soils (or normal soils) are of the solonised type—that is, sodium and magnesium have accumulated in the clay fraction at the expense of calcium. It seems likely that this is due to age-long treatment with soluble salts from the ocean, brought in by the rainfall, under conditions of very restricted leaching. Furthermore, calcium carbonate accumulation in the subsoil is characteristic. The surface, or A, horizon is typically non-calcareous except in one group associated with morrel timber.

Table 5 gives the analyses of soils from the Fitzgerald Peaks district. These results show the calcium carbonate accumulation in the subsoil. Also, the composition of the replaceable base fraction shows the surface soils to be of the calcium-magnesium type but, in the subsoil, sodium, and, to some extent, magnesium have accumulated at the expense of calcium with the formation of magnesium-sodium or sodium-magnesium clays. The high concentration of water soluble salts in the subsoils is apparent.

The soils of the woodland and mallee areas fall into eight main groups:—

A. Sandy surfaced types with a calcareous, clay subsoil. Considerable areas of this group are related to the Miocene sediments.

B. Sandy loams and loams with a calcareous, clay subsoil of the salmon gum forests which are probably largely related to the Precambrian rocks.

C. Powdery calcareous soils, generally associated with morrel timber. They are typical valley soils but are also associated with basic rocks in some instances.

D. Brown, red brown and red loams and clay loams with a calcareous, clay subsoil associated with the basic intrusive rocks of auriferous areas.

E. Clay loams and clays carrying both salmon gum and gimlet woodland and mallee timber.

F. Sandy soils carrying mallee associations.

G. Low lying sandy soils apparently forming on the sites of old lakes or salinas.

H. Red sandy soils associated with the areas of basic intrusive rocks.

A.—*The sandy-surfaced soil types with a calcareous clay subsoil.*

This group includes a number of soil types which are more or less solonised and which show signs of columnar structure in the surface of the subsoil, apparently due to enhanced leaching promoted by the sandy surface.

The surface, or A. horizon, is typically a structureless sand, brown to grey brown and sometimes red brown on the surface, and more or less bleached in the subsurface. The sand rests abruptly on a sandy clay subsoil, which cements in the upper portion on drying out, and which exhibits a more or less irregular surface suggestive of incipient columnar structure. The upper portion of the subsoil is typically non-calcareous but finely divided calcium carbonate as well as calcareous nodules commonly occur from 18 inches to 2 feet below the surface. This subsoil may be described as of massive structure and commonly is of an olive or drab colour, although brown and red brown coloured types occur.

Analyses show the subsoil clay to be of the magnesium-sodium type apparently in equilibrium with calcium carbonate. Phosphate is generally very low and potash high. Salts have accumulated in the subsoil under virgin conditions but readily leach following clearing (Teakle and Burvill (1938)).

TABLE 5.

Analyses of Soils from the Fitzgerald Peaks District and representative of the portion of the 3,500 Farms Scheme Investigated.

Soil Group.	Serial No.	Depth.	Horizon.	pH.	$CaCO_3$.	T.W.S.S.	Total Exchangeable Bases (m.e./100gm. Soil).	Proportion of Total Bases (Percentage).			
								Ca.	Mg.	K.	Na.
		inches.			%	%					
B*	A135	0—9	A_1	7·61	·06	·0355	6·08	61	31	3	5
	136	9—11	A_2	6·19	·05	·0335	3·71	22	64	3	11
	137	11—21	B — C	6·58	·09	·0245	17·04	13	51	1	35
B	138	0—3	A	7·29	·23	·0695	9·46	51	40	4	5
	139	3—15	B	8·42	8·57	·4715	22·03	17	40	8	35
	140	15—30	B — C	8·45	1·43	·3275	15·17	15	39	8	38
C	141	0—6	A	7·86	1·20	·1215	22·30	64	24	8	4
	142	6—27	B_1	7·91	10·8†	·2985	19·09	36	43	10	11
	143	27—39	B_2	8·15	30·2†	·3215	13·76	18	37	16	29
A	144	0—9	A	7·38	0 05	·0465	4 32	47	30	3	20
	145	9—21	B_1	8·16	·73	·3670	18·68	8	37	14	41
	146	21—30	B_2	8·16	1·07†	·4265	17·54	7	33	11	49

* Site adjacent to granite outcrop and not typical of the group. An immature soil. † Exclusive of limestone rubble.

(Analyses made in the Government Chemical Laboratory.)

Table 6, page 219, shows the occurrence of water soluble salts in group A.

If the lower limit of the high salinity range be taken as 0.20 per cent. total water soluble salts in the surface foot and 0.40 per cent. in the second foot, 35 per cent. of the sites would fall in the high group. However, the leaching of salts following clearing renders group A safe, as far as salinity is concerned, except in areas of poor drainage where a water table may develop.

Soils of this group are associated with a variety of vegetation types, the first natural subdivision being into woodland and mallee phases. Perhaps the most characteristic is the redwood-ribbon bark woodland, but salmon gum, merrit, and occasionally morrel are common. The mallee phase carries a variety of species including *E. eremophila, E. calycogona, E. dumosa,* and *E. oleosa.*

Various teatrees (*Melaleuca* spp.), *Eremophila* spp., *Acacia* spp., and other shrubs are commonly associated with both woodland and mallee phases.

This group may be regarded as belonging to a fasc* which includes such series as Circle Valley, Scaddan and Pallarup.

It is not of high fertility, but is very economical of moisture and very suitable for farming under low rainfall conditions.

B.—*Sandy loams and loams with a calcareous clay subsoil.*

This group represents the typical salmon gum and salmon gum-gimlet woodlands and typically forms in the valleys and on gentle slopes. Very old alluvial material and the acidic or sub-basic Precambrian rocks are probably the usual parent materials.

The soil is typically a brown to red brown sandy loam to loam, non-calcareous and approximately neutral in reaction, with a clay subsoil of similar but lighter colour. The subsoil is calcareous and the calcium carbonate occurs both finely divided and as concretionary nodules.

As in the other groups solonisation is characteristic. The clays of the surface horizons are of the calcium-magnesium type but the subsoil is of the magnesium-sodium type. (See Table 5.)

Salinity is fairly high and about 50 per cent. of the sites sampled in the virgin state would fall in the high salinity class. As leaching would proceed fairly rapidly following clearing, the salinity problem would not be severe.

Table 6 shows the salinity of the samples examined in this investigation.

While the vegetation is normally predominantly salmon gum or salmon gum and gimlet, other species occur including morrel, merrit and yorrell, and a variety of mallees.

The undergrowth varies considerably but may include centipede bush, salt bush, hop, *Daviesia sp.*, quondong, teatrees and acacias.

This group of soils forms excellent farming land, particularly when the rainfall is generous. Water soluble salts leach fairly readily in these types where the timber has been cleared and the salt problem is not deemed very serious even where the soil was affected by considerable salinity in the virgin state.

C.—*Powdery, calcareous soils, generally associated with morrel timber.*

The soils of this group are representative of the brown, grey brown, and grey snuffy morrel types of the drier wheatbelt and, to some extent, of the "kopi" soils of the Salmon Gums district. They may be regarded as members of the fasc which includes such series as the Beete, Campion, Westonia and Milarup. Perhaps the most characteristic features of these soils are—(a) the snuffy or powdery structure, (b) the occurrence of calcium carbonate on the surface as well as in the subsoil.

* The term fasc is used to denote a group of soil series, usually over a range of districts, which are generally similar in origin and development but between which local differences are sufficient to classify them as distinct series. (Milne, 1935.)

In the area under discussion this group of soils typically carries a woodland of morrel with an undergrowth including such species as boree (*Melaleuca pauperiflora* and *M. quadrifaria*), daisy, *Eremophila* spp., salt bushes (*Atriplex spp.*), various *Acacia* spp., etc. Sometimes merrit predominates, and various mallees may occur as an undergrowth.

While these soils typically occur in the valleys, frequently forming a band between the salmon gum woodland and the lakey country, in some instances they have developed on basic dykes and outcrops associated with auriferous country. It is thought (Teakle, 1938, p. 154) that the nature of the vegetation plays an important part in the surface accumulation of the calcium carbonate. In the first place, the concentration of roots in the surface layers effectively restricts penetration of water, and, in the second place, the leaf and bark fall of these plants may add more calcium to the surface than other types of vegetation.

The typical profile is a surface horizon about 12 inches deep of a brown to grey brown powdery, calcareous sandy loam resting on a brown to fawn clay loam to light clay which is highly calcareous. Small and large nodules of calcium carbonate may occur in the subsoil and sometimes a calcium carbonate pavement is encountered. Red brown and even red types as well as grey types have been included in this group.

The subsoil clays are highly solonised. (See Table 5.) Chemically, plant foods are more generously supplied than in most other groups but the salinity is undesirably high as about 60 per cent. of the sites fall in the high group, Table 6. As leaching is restricted and the capillary properties of this soil are above normal. loss of water soluble salts after clearing is slow and there is a tendency to surface accumulation in the form of bare patches resulting from surface evaporation of moisture drawn from the subsoil by capillarity. Furthermore, these soils appear to be unsuitable for wheat growing in low rainfall areas until compacted by stock and the physical properties become altered by pasture establishment and cropping with very shallow cultivation.

In view of these disabilities, soils of this group, even when not saline, are of low value for wheat production, particularly in the initial stages, and where saline have a low agricultural value.

D.—*Brown, red brown and red loams and clay loams, with a calcareous, clay subsoil, associated with the basic intrusive rocks of auriferous areas.*

Areas of auriferous country, characterised by low hills and ranges and basic intrusive rocks, occur in a number of places of which Mount Holland, Forrestania, Hatter Hill and the Bremer Range are representative. The soils of the basic rocks of these areas are heavy textured and redder in colour than other soil types and carry a more varied range of species in the eucalyptus woodland.

To deal first with the vegetation, it is noteworthy that, in addition to salmon gum, gimlet, morrel and merrit, various blackbutts (including *E. corrugata*) and tree forms of *E. calycogona*, *E. annulata* and *E. dumosa* are common. Besides these, *Melaleuca pauperiflora*, *M. quadrifaria*, grey bush, various *Eremophila* spp. of the Kalgoorlie type, and acacias are important in the vegetation associations.

The soils range from brown to red loams and clay loams and often show a surface sprinkling of blackish, ferruginous gravel. Greenstone pebbles sometimes occur on the surface and are often imbedded in the subsoil clay. The subsoil shows heavy clay accumulation and is typically calcareous. Decomposing basic rock in always encountered at shallow depths.

Little is known of the chemical properties of these soils except that they are generally highly saline (see Table 6), a fact associated with the heavy texture and

restricted leaching. Agriculturally, they would be highly productive under a generous rainfall, but under the conditions prevailing, must be regarded as unsuitable for wheat growing except in abnormally wet years. On account of the heavy texture, improvement in salt status would be slow under light rainfall conditions and after the initial crop or two development for pasturage such as wimmera rye grass and saltbushes over a period of years would be advisable before wheat growing was again attempted.

E.—*Clay loams and clays of the gimlet and salmon gum woodlands and of mallee areas.*

This group of soils resembles those of group D in the property of a heavy texture but are typically valley soils and are not obviously associated with any particular rock type. In colour they show less of the red shades than group D and are generally associated with a gimlet and salmon gum woodland. In the eastern portions of the reconnaissance in the vicinity of the Salmon Gums country, a mallee or stunted eucalypt association often replaces the woodland and the geology is probably different from more western areas.

The soil profile consists typically of a brown or red brown clay loam or clay, resting on a brown or red brown calcareous, clay subsoil of considerable thickness. Crabholes, or gilgais, are common. Soil series of this group would belong to the same fase as the Kumarl and Dowak series of the Salmon Gums area, the Camm series of the Lakes district and the Welbungin series of the Lake Brown area.

Besides gimlet and salmon gum, merrit and morrel with boree, native cherry, acacias and other plants frequently occur on the woodland association.

The mallee association of the eastern portion includes *E. diptera,* merrit, yorrel and *E. oleosa*, with an undergrowth of melaleucas, acacias, eremophilas, etc.

This group of soils exhibits an undesirable degree of salinity as some 75 per cent. of the samples analysed fall in the highly saline class. In the absence of salinity, these heavy textured soils are very productive when the rainfall is adequate and superphosphate is used. Under low rainfall conditions, however, returns are usually disappointing on account of the high moisture capacity of the soil and restricted penetration of the moisture. Where salinity is unduly high, experience at Salmon Gums indicates the first crop of wheat is usually satisfactory but disappointing returns are obtained subsequently. As wimmera rye grass and trailing saltbush do well on soils of this group, it is good practice to establish these for pasture purposes after the first wheat crop. The preliminary results of experiments at the Salmon Gums Research Station suggest that a period under pasture between wheat crops may contribute materially to the reduction in salinity and, hence, the reclamation of this important group of soils.

F.—*Sandy soils carrying mallee associations.*

Considerable areas of mallee country are associated with sandy soils in which a clayey subsoil, usually more or less calcareous, occurs at depths generally in excess of one foot. These soils belong to the fase which includes the Doust series of Salmon Gums and are generally of low fertility and subject to wind erosion under cultivation.

The profile consists of a grey, grey brown or yellow brown sand, somewhat bleached in the subsurface, resting on a brown to greenish brown cementy, sandy clay.

Common species in the vegetation associations are *Eucalyptus dumosa, E. eremophila, E. leptophylla* (tree and mallee forms), redwood, broombush, *Grevillea* spp., *Daviesia* spp., *Boronia* sp., centipede bush, and a variety of

psamophilous plants. The salt status is low and is not a factor in the evaluation of this type.

As these soils have been generally classified as second class, they were not considered as an important factor in the land settlement scheme. However, their favourable moisture relations render them of value in the low rainfall areas but they need the use of a system of crop rotation which will raise the fertility level and control soil erosion.

G.—*Low lying sandy soils apparently forming on the sites of old lakes or salinas.*

Extensive areas of sandy surfaced soils occur in depressions and low-lying areas surrounding the salt lakes or salinas. The profile typically consists of a grey to grey brown sand, with a whitish subsurface layer, resting on an olive or greenish calcareous sandy clay subsoil. In many respects, the type resembles certain types of group A but drainage conditions are different, the subsoil may be more highly saline and there is a danger from a rising salt water table following the clearing of the surrounding country. The vegetation always includes certain characteristic plants such as *Melaleuca thuyoides* and swamp gimlet. Redwood, *E. leptophylla* and a variety of melaleucas also occur in some sites.

Experience throughout the settled wheat belt shows the liability of soils of this group to become excessively saline within 10 or 20 years of the development of the higher land and, consequently, it is considered unwise to include them as types of permanent value as arable land. They may be safely used in association with more suitable types because, contrary to popular belief, their development will not promote salt encroachment on more valuable land elsewhere. But it should be realised that in the course of time salinity may render them unprofitable for cultivation.

Fortunately, the area of this group of soils is not large and they have been given only second class value in the Lands Department classification. Consequently, they are of little importance as a factor in the land settlement under consideration.

H.—*Red sandy soils associated with the areas of basic intrusive rocks.*

Associated with the low hills and ranges of basic intrusive rocks are areas of reddish woodland soils which appear distinct from any other group and resemble certain of the goldfields types rather than more coastal soils. They occur principally in the Bremer Range which is included in the Coolgardie soil region rather than in the Fitzgerald region (Teakle 1938).

The woodland is characteristically open and includes salmon gum, gimlet, a large tree form of *E. dumosa,* a tree form of *E. eremophila,* morrels, and merrit. Smaller species include borees, teatrees, eremophilas, spinifex, hop, acacias and a variety of mallees.

The profile features include a fine sandy or sandy loam non-calcareous surface, red or red brown in colour and commonly gravelly, and a red or light red calcareous clay subsoil. Generally clay accumulation occurs at a depth of 6 to 12 inches below the surface and lime at 15 inches.

The soils are characteristically non-saline (Table 6) and, under a suitable rainfall, should be good agricultural land. Unfortunately, they occupy only a very small area and, consequently, do not materially affect the land settlement problems of the area. They are interesting as an exception to the general rule for the areas of salt accumulation in clay subsoils. Perhaps the constitution of the clay fraction of the soils of this group differs from that of the more general soil types.

TABLE 6.

Distribution Table showing the Incidence of Salinity in the Soil Groups described in the 3,500 Farms Scheme Reconnaissance.

Soil Group.	Depth.	Percentage of samples in each range of Total Salt Concentration* expressed as per cent. in dry soil.												Number of Samples.	Percentage of Samples in High Salinity group.
		Up to .05.	.05 to .10.	.10 to .20.	.20 to .30.	.30 to .40.	.40 to .50.	.50 to .60	.60 to .70.	.70 to .80.	.80 to .90.	.90 to 1.0.	1.0 to 1.1.		
	inches.														
A	0—6	65	22	9	2	2	...	...	...	..	..	..	...	105	4
	0—12	41	16	21	15	6	1	...	...	..	...	..	...	177	22
	12—24	**6**	**7**	**11**	**15**	**26**	**16**	**12**	**4**	**2**	**1**	...	...	**196**	**35**
B	0—12	30	14	27	14	11	3	1	.	.	...	...	...	119	29
	12—24	**4**	**3**	**8**	**15**	**19**	**15**	**20**	**5**	**7**	**4**	...	...	**117**	**51**
C	0—12	22	14	21	20	9	5	4	1	3	1	...	...	177	43
	12—24	...	**2**	**5**	**10**	**21**	**19**	**11**	**8**	**14**	**7**	**1**	**2**	**165**	**62**
D	0—12	9	4	8	17	29	17	4	8	4	...	...	..	24	79
	12—24	...	**5**	...	...	**13**	**4**	**4**	**9**	**26**	**39**	...	...	**23**	**82**
E	0—12	10	15	18	17	19	6	7	3	3	2	...	..	93	57
	12—24	**2**	**3**	**2**	**9**	**8**	**19**	**11**	**12**	**12**	**18**	**1**	**3**	**91**	**76**
F	0—12	100	...	...	...	..	..	.	..	..	...	...	...	11	nil
	12—24	**18**	**37**	**27**	**18**	...	...	..	...	...	...	...	...	**11**	**nil**
H	0—12	63	19	12	6	...	..	..	...	...	...	...	...	16	6
	12—24	**12**	**13**	**6**	**25**	**19**	**19**	**6**	...	..	...	...	...	**16**	**25**

Low and moderate salinity. | High salinity.

* Determined by the Wheatstone Bridge method described by Davis and Bryan (1910).

The Incidence of Soil Salinity.

There is no doubt that the soils of the area examined are closely related to those of other portions of the wheatbelt and could reasonably be expected to respond to agricultural development in a similar way. Experience in the Salmon Gums district pointed to a disturbing factor—soil salinity—which has already been discussed, and the primary purpose of the reconnaissance was to determine the incidence of salinity in the first class soils of the area proposed for settlement.

On account of the importance of soil type in the movement of water soluble salts following clearing (Teakle and Burvill, 1938) the available data with respect to salinity have been considered for the groups of soils described above and are summarised in Table 6.

From this table it is evident that all of the soils in the virgin state, except group F, are characteristically more or less saline and that the heavy textured types of groups C, D and E are generally excessively saline. The lighter textured soils of groups A, B, F and H are less seriously affected and when it is known that leaching following clearing will bring about substantial if not complete reclamation of these types, it is evident that the soil salinity problem is largely confined to soils of groups C, D and E. The importance of this will be considered in the next section, after soil salinity in relation to certain factors has been discussed.

(a) *Soil salinity and vegetation.*

While certain plants such as samphire, and to a less extent, one of the bores (*Melaleuca quadrifaria*) and grey bush (*Cratyslylis conocephala*) may be commonly associated with saline soils, it was found that the vegetation, as a general rule, was of little assistance as an indicator of excessive salinity. Apparently, the species of the wheat belt areas have a wide range of salt tolerance and salt is not normally an important factor in determining the plant association which establishes on the normal soil types.

Table 7 shows the incidence of salt in soils on which a number of characteristic species were important in the vegetation association.

The apparent importance of gimlet as an indicator of salinity is due to another factor—the fact that gimlet commonly grows on heavier textured soils in which salt will accumulate on account of restricted leaching.

(b) *Soil salinity and elevation.*

Following on the definition of a soil salinity problem in the area, Dr. Ward, the Government Geologist of South Australia, and Mr. Lockhart Jack of his department, were consulted by the Development and Migration Commission regarding the problem. From a consideration of possible underground water movements and the effects of clearing the higher lands, they suggested that—

1. A relief map would provide the key to the problem of distribution of saline lands;
2. The high lands would be safe and likely to improve.

Further, they recommended that—

1. Traverses be run through several representative sections, and levels taken;
2. Soil salinity and soil profile observations be made along these traverses and plotted to show the safe and dangerous levels.

In effect, this information had already been obtained by means of aneroid levels taken during the course of the reconnaissance and using the railway surveys as bases.

TABLE 7.

Distribution Table showing the Salinity of Soils of the 3,500 Farms Scheme on which various Species formed an important fraction of the vegetation association. The ranges represent Total Water Soluble Salts in the Subsoil (second foot).

Species.	Percentage of total recorded occurrences of the species in each range of total water soluble salt concentration (per cent in oven-dry soil).											Total Recorded Occurrences.
	0·05 and lower.	·05 to ·10.	·10 to ·20.	·20 to ·30.	30 to ·40.	·40 to ·50.	·50 to 60.	·60 to ·70.	·70 to ·80.	·80 to ·90.	·90 to 1·0.	above 1·0.	
Salmon Gum	6	4	6	17	17	15	14	8	8	4	1	...	197
Gimlet	2	2	2	7	5	11	14	9	22	22	4	...	55
Morrel*	5	3	8	11	26	13	11	9	9	3	1	1	206
Merrit	1	3	6	8	12	16	11	8	14	11	6	4	141
Redwood	6	1	11	19	24	19	12	3	3	2	...	..	108
Grey bush	...	...	...	20	10	20	10	10	20	...	..	10	10
Boree (*Melaleuca quadrifaria*)	2	2	6	6	10	10	19	8	19	8	9	1	53

* Includes *Eucalyptus longicornis*, *E. melanoxylon* and *E. oleosa*.

TABLE 8.

Distribution Table showing the Salinity of Woodland Soils of the portion of the 3,500 Farms Scheme in relation to elevation above sea-level. The ranges represent Total Water Soluble Salts in the Subsoil (second foot).

Elevation Range. (Feet above sea level)	Percentage of total sites taken in each elevation range falling in each range of total water soluble salt concentration (per cent. in oven-dry soil).											Total Sites in the Elevation Range.
	0·05 and lower.	·05 to ·10.	·10 to ·20.	·20 to ·30.	·30 to ·40.	·40 to ·50.	·50 to ·60.	·60 to 70.	·70 to ·80.	·80 to ·90.	·90 to 1·0.	above 1·0.	
Below 1,000	8	8	23	8	7	31	15	...	...	...	...	...	13
1,000—1,100	3	3	6	11	14	17	11	3	11	3	12	6	35
1,100—1,200	5	3	7	20	19	13	17	5	3	8	...	...	60
1,200—1,400	5	...	5	9	13	13	9	13	23	5	5	...	22
Above 1,400	...	...	25	25	25	...	25	...	...	...	...	...	4

The relation between elevation and incidence of soil salinity is shown in Table 8.

These results conclusively show that the incidence of soil salinity in the virgin woodland country bears no relationship to elevation. Consequently, a relief map would be valueless as an indicator of safe and dangerous lands.

The soil profile studies leave no doubt that the dominant factor in salt accumulation is the permeability of the soil to moisture. Accepting the rainfall as the source of the water soluble salts, there can be no question that heavy clay soils, and types in which the combination of soil profile and vegetation cover also greatly restrict leaching, will show an accumulation of these salts irrespective of elevation. Subsequent behaviour of the water soluble salts following clearing of the vegetation will be dependent on the permeability of the soils and this is also a direct function of soil type. Teakle and Burvill (1938) have discussed this, and the application of the principle has already been made in the discussion of the various soil groups studied in this area.

Of course, there will be a rise in the water table after clearing and the low lying soils will become affected when the salt water level comes within a few feet of the surface. Soils of Group G are particularly liable to be affected, but micro-relief rather than general relief would be necessary to define these areas. Again, the soil type seems a more satisfactory method of defining such areas liable to be affected by soil salinity in the course of years.

(e) *The composition and source of the water soluble salts.*

The total water soluble salts may be extracted by treating the soil with water. In this work 5 parts of water were used to one part of dry soil and the resulting extract analysed by the usual methods. Analyses show that the dominant constituent is sodium chloride or common salt. The average of analyses representing 77 samples shows sodium chloride to constitute 70.2 per cent. of the total water soluble salt fraction. The proportion may be higher in the more saline samples and becomes lower as the salt content of the soils decreases. Regarded from the aspect of supply of plant nutrients, the analyses indicate that these woodland soils are well supplied with nitrate and with water soluble potassium, calcium and magnesium. Sulphates are high and phosphate appears to be the ingredient most needed for fertiliser purposes.

Table 9 gives the average of analyses reported in Table A of the appendix.

TABLE 9.

Average of Analytical Data representing 77 Samples of Soil from the 3,500 Farms Scheme.

Ion.	ppm Dry Soil.	Ion.	ppm Dry Soil.	Empirical Salt Combination.	ppm Dry Soil.	Per cent. of T.W.S.S.
Cl	1,627	Ca	52	$CaCO_3$ ..	10	·3
HCO_3	307	Mg	55	$Ca(HCO_3)_2$.	194	5·1
CO_3	6	K	22	$Mg(HCO_3)_2$.	193	5·0
SO_4	490	Na	1,429	$MgSO_4$ ..	115	3·0
NO_3	21	...	..	K_2SO_4 .	20	·5
				KNO_3	34	·9
Totals	2,451	...	1,558	Na_2SO_4 .	573	15·0
				NaCl	2,680	70·2
Total Water Soluble Salts in Empirical Combination					3,819	100·0
Excess cation as Sodium					190	...

The composition of the water soluble salt fraction approximates that of the salts of sea water and, as pointed out by Teakle (1937), there is little doubt that they have their origin in sea-water. Further, it is most probable that the sea-water was blown inland as an evaporated spray and later deposited on the soil in the rainwater. Analyses of rainwater collected over a 4-year period on the Salmon Gums Research Station show that about 27 pounds of salt are deposited per acre annually by this avenue and it was calculated that it would take only 37,000 years to account for the amount of salt in the soils of the region, assuming an average depth of 50 feet.

The deposition of salt in the rainwater at the Merredin Research Station was only 16 pounds per acre per annum.

(d) *Relation to soil salinity in other districts.*

It has been contended that, prior to clearing, soils of established wheat areas were just as saline as those of this portion of the 3,500 Farms Scheme. There is no factual basis for this statement.

Of course, soil salinity may be recognised throughout the southern portion of the State, irrespective of rainfall, but in the present agricultural areas this is largely due to the movement of saline ground waters subsequent to the development of the country, and presents a problem not yet affecting the areas of virgin country under discussion. Furthermore, the actual area of arable land at present damaged by this manifestation of salinity is relatively small—probably of the order of magnitude of 5 per cent. of the farming lands of the wheat belt.

All available evidence indicates that the soil salinity problem under investigation is confined largely to an area east of Newdegate and south of Southern Cross where the accession of salt per medium of the rainfall, is high (about 27 pounds per acre per annum) and where, under virgin conditions, the low precipitation per wet day is inadequate for the leaching out of the salts when deposited on the clayey woodland soils.

A body of information on the salinity of woodland soils of the salmon gum, gimlet and morrel types has been obtained from a number of special traverses through representative portions of the wheatbelt. (See Fig. 1.) The information is compiled and represented in the scatter diagram, Fig 3. The analyses in this case are expressed in terms of salt (sodium chloride) and not total water soluble salts used in the rest of the investigation. The lower limit for highly saline soils has been taken as 0.30 per cent. salt (NaCl) in the subsoil (second foot). Each dot represents the analysis of a subsoil sample from a site examined along the traverse and the position is given by the scale. Dots above the 0.30 per cent. salt line thus represent excessively saline samples and those below the line samples of low or moderate salinity.

Examination of the scatter of the dots along the various traverses in Fig. 3 shows—

(a) Fourteen out of 38 sites were highly saline on the Lake King-Marble Rock traverse.

(b) From the Marble Rock-York traverse it is evident that over 50 per cent. of the sites were highly saline between Marble Rock and a point a few miles east of Karlgarin. West of this point normal woodland soils were rarely saline.

(c) Between Marble Rock and Campion a high proportion of saline sites was obtained as far north as Holleton. North of this district no highly saline sites were sampled until the lake country south of Campion was reached. This area is notoriously saline, a fact which correlates with the information submitted in the scatter diagram.

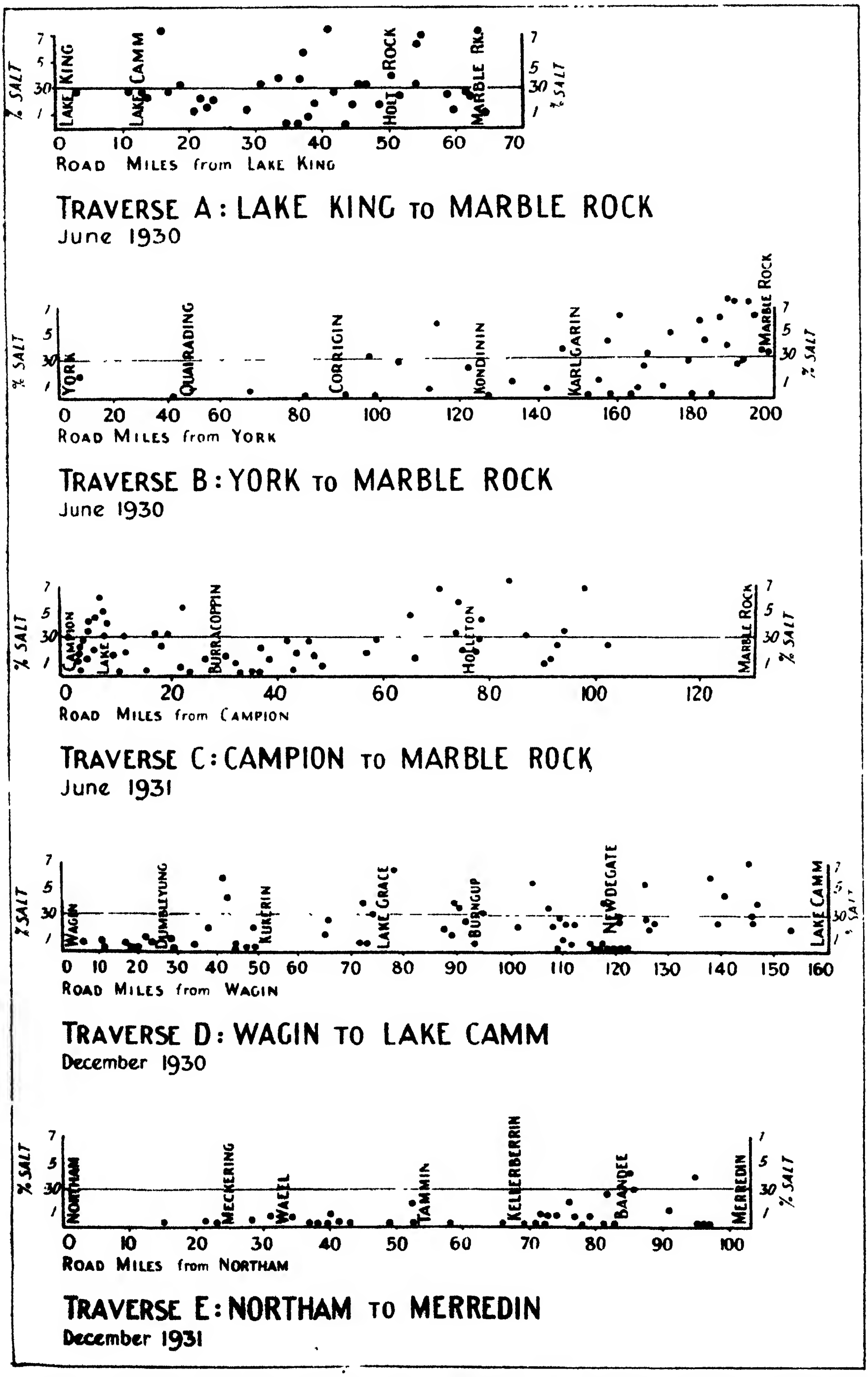


Fig. 3.—Scatter diagram showing the concentration of salt (sodium chloride) in the subsoil (second foot) of woodland soils ("first class") along five traverses representing settled parts of the wheatbelt.

(d) Between Lake Camm and Wagin, soil salinity is relatively uncommon in the normal woodland soils west of Newdegate. A considerable proportion of the samples taken east of Newdegate were saline.

(e) Between Merredin and Northam the normal woodland soils were rarely saline.

Another traverse, made on 29th October, 1930, between Salmon Gums and Coolgardie, established the high incidence of salinity in this low rainfall area. Only two of eight sites fell in the low salinity group and the salt (NaCl) contents of the subsoils (second foot) of the other six sites ranged from 0.41 to 0.82 per cent.

On these traverses, virgin soils were sampled wherever possible but, in the extensively developed areas, samples from cleared land had to be taken in some instances. This affects the mathematical aspects of the situation but does not invalidate the conclusion that the soil salinity problem recognised in the Salmon Gums district and the portion of the 3,500 Farms Scheme investigated is localised and does not extend to a serious degree to the farming areas west of Newdegate and Karlgarin and north of Holleton.

The Significance of the Soil Salinity Problem as it affects the Land of the 3,500 Farms Scheme.

As a result of the reconnaissance survey described, it was concluded in the report of 10th February, 1930, that "The investigations indicate that there is a very serious alkali* problem in the area in question. It must not, however, be regarded as a condemnation of the area." In accordance with the facts presented above, it was pointed out that the heavier soil types (that is, those represented by groups C, D and E) were most seriously affected, and, in an area of limited rainfall, the lighter soil types, which are relatively free of alkali, must be regarded as more suitable for wheat growing.

Ten years of further experience with and close investigation of this problem establish this conclusion and the recent reorganisation of farming operations in the Salmon Gums district has been based on the fact that the lighter soil types in this region are most suitable for safe wheat growing.

The results of subsequent research work have laid a foundation for an estimate of the magnitude of the soil salinity problem in the area covered by the investigation.

At the outset, it must be emphasised that the results of soil analyses for total water soluble salts must be regarded and evaluated for any climatic zone in the light of both soil type and numerous samples.

1. Soil type is of prime importance as it largely determines the behaviour of the water soluble salts after clearing.

2. Large numbers of samples must be taken to represent each soil type so that a statistical treatment of the results may be made.

By this means an estimate of the chances of damage from soil salinity on each soil type is possible, although any single analysis of a soil of unknown type would have little value by itself.

It may reasonably be assumed that the areas of the various types of woodland soils are proportional to the numbers of sites sampled in each group except in the case of group A in which the factor 1.5 should be arbitrarily used as these soils

* Alkali is the old American term which in recent years has been generally replaced by the more appropriate term "salinity."

were purposely sampled less intensively than the others. If this assumption be accepted, the relative areas of the types of woodland soils would be:—

Group A	196 x 1.5 =	294
" B	..	119
" C	..	177
" D	..	24
" E	..	93
" H	..	16
	Total	723

On the basis of the information submitted by Teakle and Burvill (1938) concerning the movement of salt in soils under light rainfall conditions, the percentage of area of soils dangerously saline for wheat growing could be calculated as fol-

Soil Group.	Number of Saline Sites.	Resistance to Reclamation Factor.	Net Saline Sites after Clearing.
A ..	69	0	0
B ..	61	·40	24
C ..	110	·50	55
D ..	20	·75	15
E ..	71	·75	53
Total ..		... ..	147

On this reasoning 147 sites would represent 20 per cent. of the total area of woodland soils.

It is admitted that the powdery morrel types of group C are unsatisfactory for wheat growing under low rainfall conditions whether saline or not saline. Therefore, in order to arrive at an estimate of the proportion of woodland soils more or less unsuitable for wheat growing, both on account of salinity and the factor of morrel soils, the remainder of the sites of group C, namely 122, must be added to the "net saline sites after clearing." This brings the proportion of woodland soils more or less unsuitable for wheat growing to 37 per cent.—or about one-third.

As the woodland soils probably occupy from one-quarter to one-third of the total area, this fraction of the "first class" soils represents about 10 per cent. of the total area.

At the present time there is no economic urge for increased wheat and wool production and a policy of consolidation in settled areas is amply justified. However, when the demand arises, there seems no reason from the standpoint of soils why settlement should not spread across the area in question. It is true that certain easily recognisable soil types, constituting about one-third of the total area of woodland soils, would not be suitable for wheat growing, but the other woodland types, together with the better types of light land, should be satisfactory. Furthermore, research work on the saline and morrel or "kopi" soils of the Salmon Gums Research Station indicates that these, while risky for wheat growing, are generally suitable for wimmera rye grass production. This agricultural value as pasture soils could be considered in a reorganised settlement programme which would take advantage of the knowledge of the soil types of the area and the experience gained as a result of many years of farming and agricultural research in the Salmon Gums and other districts.

TABLE A (APPENDIX).

Composition of Total Water Soluble Salts (1 : 5 Water Extract) of Soils of the 3,500 Farms Scheme. Samples represent the surface 24 inches, except where otherwise indicated.

(Results expressed as ppm. oven-dry soil).

ion.	Composite 1—22.	Composite 23—36.	Composite 37—50.	Composite 51—61.	Site 62.		Site 63.		Serial Numbers.		
					Group E.		Group E.		Group B.		
									135.	136.	137.
					0—12 inches.	12—24 inches.	0—10 inches.	10—24 inches.	0—9 inches.	9—11 inches.	11—21 inches.
Cl	2010	1250	1850	1360	4450	4290	2630	3840	115	105	865
CO_3	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*	45	*nil*	*nil*	*nil*
HCO_3	390	381	445	442	240	381	373	351	51	45	132
SO_4	609	282	508	432	1029	1523	547	1621	123	82	181
NO_3	13	5	11	8	54	5	7	2	3	4	7
Ca	65	39	93	47	63	50	51	36	35	6	22
Mg	46	28	74	83	127	133	55	96	26	13	20
K	16	26	20	40	20	Tr.	16	26	16	10	Tr.
Na	1860	1220	1786	1401	3305	3630	2062	3356	98	110	1023
NaCl (calc. from Cl) ...	3310	2060	3050	2240	7330	7080	4330	6330	189	173	1425
T.W.S.S.*	4470	2560	4280	3680	9240	9890	5690	8900	355	335	2450
Per cent. as NaCl ...	74	80	71	61	79	72	76	71	53	52	58

* Total water soluble salts.

TABLE A (APPENDIX)—*continued.*

Ion.	Serial Numbers.								
	Group. B.			Group C.			Group A.		
	138	139.	140.	141.	142.	143.	144.	145.	146.
	0—3 inches.	3—15 inches.	15—30 inches.	0—6 inches.	6—27 inches.	27—39 inches.	0—9 inches.	9—21 inches.	21—30 inches.
Cl	110	1810	1180	160	1170	1580	105	1665	1990
CO_3	*nil*	*nil*	51	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*
HCO_3	258	570	363	318	318	264	87	336	387
SO_4	181	1037	502	74	132	255	49	214	428
NO_3	44	34	35	23	38	88	7	17	6
Ca	50	43	14	155	140	45	13	52	16
Mg	25	35	24	69	96	44	13	46	39
K	45	24	5	16	45	29	10	31	38
Na	199	1686	1275	149	765	1229	149	1562	1723
NaCl (calc. from Cl)	181	2980	1940	257	1930	2550	173	2745	3280
T.W.S.S.*	695	4715	3275	1215	2985	3215	465	3670	4265
Per cent. as NaCl	26	63	59	21	65	79	37	75	77

* Total water soluble salts. Analyses made in Government Chemical Laboratory.

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PASTURE COMPETITION, DONNYBROOK.

M. CULLITY, Senior Agricultural Adviser.

The Donnybrook Dairy Farmers' Association inaugurated a pasture competition early in 1932, which continued until 1936, when the final awards were made. Owing to the very satisfactory outcome of that competition, it was decided to continue this work on a different basis of judging. In the original scheme of judging, consideration was given to bulk, permanency of the sward, its food value, the value of the plot as an experiment or demonstration, and the cultural treatment, thus introducing many factors, the comparative value of which were difficult to assess. Further, because of the influence of plants previously existing in the pastures, it did not necessarily follow that the most meritorious and informative result would gain the award. However, the competition was finally won with a very fine pasture of subterranean clover and perennial rye grass.

In order to overcome the difficulties that were present in the original competition, and having regard to the trend in pasture improvement work in this State,

it was suggested that, in a further competition to commence in 1937, the award would be given to that farmer most successful in establishing a new species of grass in his pasture.

In order to emphasise the necessity of sowing grass seeds on a thoroughly prepared seed bed, a separate competition was arranged for this work. The scale of points adopted for judging this was as follows:—

Fineness and freedom from clods	..	40 points
Freedom from weeds	.. .. ..	30 points
Consolidation	.. ..	30 points
Total	.. ..	100 points.

Judging of the plots was carried out during the period June to September and the results are as indicated in the following table:—

Name.	Fineness and Freedom from Clods.	Freedom from Weeds.	Consolidation.	Total.
Maximum Points	40	30	30	100
Brockman, R. T. D. ...	37	29	26	92
Patroni, H.	37	26	28	91
Cunningham, C. J. ...	36	29	25	90
Fry Brothers	34	29	26	89
Sears, W. J.	38	23	27	88
Sharp, C. P.	34	29	25	88
Clifford, J.	35	27	25	87
Forrest, J. R.	37	23	26	86
Trigwell, T. T. (2)	34	23	26	83
Mitchell, V. C.	32	20	25	77
Martin Brothers	34	20	23	77
Egan, J.	30	23	23	76
Hearman, J.	34	15	26	75
Trigwell, T. T. (1)	31	20	23	74
Jones, A.	30	20	20	70

The following points of interest were evident during judging:—

1. All competitors endeavoured to procure a fine seed bed.
2. The use of a tyne cultivator, followed by a rolling, resulted in the breaking of the clods.
3. Rolling to consolidate the soil was carried out on most plots.
4. Sowings were delayed to facilitate weed destruction.
5. The seed was covered in only a few cases, rolling being generally relied on to press the seed into the ground.

Judging of the resultant pasture was carried out in inspections in May and October, 1938. Points were awarded according to the following scale, which is self-explanatory:—

Uniformity and density of sole ..	..	30 points
Colour and vigour	..	30 points
Percentage of new species established	..	40 points
Total	..	100 points

The results to date are as shown in the accompanying table.

Name.	Uniformity and Density of Sole.	Colour and Vigour.	Percentage New Growth.	Total.	Grand Total.
Maximum Points	30	30	40	100	200
Brockman, R. T.—					
May	22	25	30	77	. .
October	22	25	32	79	156
Jones, A.—					
May	18	30	20	68	. . .
October	24	27	31	82	150
Cunningham, C. J.—					
May	24	23	30	77	. . .
October	20	18	30	68	145
Fry Brothers—					
May	20	27	19	66	. . .
October	20	27	31	78	144
Clifford, J.—					
May	23	25	18	66	. . .
October	22	24	29	75	141
Sears, W. J.—					
May	12	15	15	42	. .
October	21	24	31	76	118
Forrest, J. R.—					
May	12	24	20	56	. . .
October	18	18	25	61	117
Egan, J.—					
May	26	25	10	61	. .
October	21	20	15	56	117
Trigwell, T. T.—					
May	20	20	12	52	. . .
October	18	20	15	53	105
Patroni, H.—					
May	5	5	5	15	. . .
October	21	22	12	55	70

In all, 15 plots were entered, but owing to various causes only 10 are now receiving attention. Reference to the failures will be made later. Eight plots were sown with *Phalaris tuberosa*, three with a mixture of *Phalaris* and perennial rye grass, two with kikuyu grass, one with perennial rye grass, and one with clovers. This latter did not comply with the intention of the competition, as only plants which can be easily established were used. Of those still in the competition, six are *Phalaris* plots, one kikuyu, two *Phalaris* and rye grass, and one rye grass.

The following comments are offered with reference to points arising from the competition.

Phalaris tuberosa.

The only plots sown with this species which failed, were those sown on scarified pasture, and on land which had just previously carried a crop of potatoes. In the first case, the difficulty of getting the seedlings established against the severe competition of the existing pasture plants was apparently too great, while the deep cultivation required for planting and digging potatoes would not leave the top soil in a sufficiently sweet condition for this plant, and a very poor result was obtained.

In each of the other plots, good results were the rule. Well prepared seed beds were used, and, after an excellent germination, strong healthy plants grew.

The rate of seeding varied from 2 to 6 lbs. per acre, the lower rates giving equally as good results as the heavier. South Australian certified seed was used on all plots.

Superphosphate was the only fertiliser, the average dressing being one bag per acre. Sowing with one exception was carried out broadcast, the seed being usually pressed into the soil with a roller. In one or two cases a drag harrow was used to cover the seed before rolling.

In Mr. C. J. Cunningham's plot, the seed was drilled in about 1 to 1½ inches below the surface, and the impression was gained from an early inspection that the sowing would be a total failure. However, the reverse proved to be the case. An excellent germination resulted, giving almost a full cover of plants in the first season. Sowing was carried out in three sections at the rates of 4, 5 and 6 lbs. of seed per acre respectively. The germination was so good that the 4 lbs. per acre section proved much too thick. As the year went on, however, owing to a slight waterlogging of portion of the paddock, a number of plants died. As a consequence, at the end of the season, the plot was not so good as was early promised. In the autumn of 1938, subterranean clover burr was sown over the paddock, giving a good mixture of *Phalaris* and clover.

In contrast to this, the plot sown by Messrs. Fry Brothers, on the top of one of the highest hills in the vicinity, where drainage is of course efficient, has improved consistently throughout the year. Sowings of 2 and 3 lbs. of seed per acre have proved ample.

Mr. J. Clifford's entry was situated on the flat land adjacent to Thomson's Brook, and although partly flooded on occasion during the winter, was sufficiently well drained to allow excellent growth.

The winning entry for the year was that of Mr. R. T. D. Brockman. This was sown on much lighter land than that used by the other competitors. The seed bed was thoroughly prepared, and sowing was carried out broadcast at the rate of 4 lbs. of seed per acre. A brush harrowing was used to cover the seed. Although the plot was reasonably even over much the greater area, some plants failed to survive in one small portion which appeared much looser and dryer than the remainder. Those plants, even in this patch, which survived the delicate seedling stage, later developed into healthy plants. The size of the plants was generally very satisfactory, particularly where existing in association with subterranean clover.

The plants sown by Messrs. T. T. Trigwell, J. R. Forrest and W. J. Sears also demonstrated that this plant could be successfully introduced into land which had previously grown subterranean clover.

In passing, reference must be made again at this point, to the plot sown by Mr. C. J. Cunningham. This plot, though it had been partially cleared for a number of years, had never carried pasture until the *Phalaris tuberosa* was sown. The success with which the plants are growing, particularly on the higher portion of the paddock, raises the question whether an old pasture site is necessary for the establishment of this species.

Phalaris tuberosa and perennial rye grass.

Mr. W. J. Sears used a mixture of 3⅓ lbs. of *Phalaris tuberosa*, 6⅔ lbs. of Clunes strain perennial rye grass, and 3⅓ lbs. of giant cow grass per acre. This plot carried a heavy cover of capeweed, which mitigated against a rapid establish-

ment of the new sown grasses. However the rye grass succeeded in getting established while the *Phalaris tuberosa* had not made such good progress. This appears to be developing along similar lines to Mr. H. Patroni's plot reported in a previous competition, and supports the conclusion previously expressed that competition in the seedling stage is a serious obstacle to this species. The competition from the rye grass was sufficient to retard its establishment.

Other plots sown in this way were those of Mr. T. T. Trigwell. All these have not been as impressive as when *Phalaris* was sown alone. The rye grass also has not been as successful as was expected. This probably was due to the severe competition from annual plants as previously referred to.

Perennial rye grass.

Only one competitor used this species, and for some reason the result has not been very satisfactory. Seed reputed to be "Colac" strain was used, but there does not appear to be any guarantee that the seed was from good pasture. The early inspections of this plot showed that very little rye grass had been established.

Kikuyu.

Two plots of kikuyu were entered. One has proved a great success, while the other was a total failure. It is believed, however, that this failure cannot be attributed to any weakness of the plant, but rather to the system of management.

Mr. A. Jones planted two paddocks of this grass, one of which planted by the rougher method to be described was for the competition. The paddock was ploughed, cultivated, and worked to a fine surface before the cuttings were dibbled in, 3 feet apart each way. The other paddock was ploughed only, and the kikuyu cuttings planted three feet apart in every third furrow. No other cultivation was carried out on this plot which was the one entered for competition. At the time of the inspection in October these paddocks had almost a full cover of kikuyu.

The other plot which was entered by another farmer was dibbled in under an oat crop. At the time of the inspections in 1938, no kikuyu was seen. All of these plots were high on hillsides away from low lying land which might assist in providing summer moisture.

The difference in the plots has been attributed solely to management. The plot which failed was grazed before the cuttings had developed into plants with a tenacious hold on the ground, with the result that all the plants were torn out by the cattle. The plot which proved successful was not grazed until at least 12 months after planting. In effect, Mr. Jones forgot he had those paddocks on his farm. The result is that he now has several acres of completely matted kikuyu pasture which will prove useful to him in the coming seasons. Twenty acres have been established, or are in the process of being established.

The fertiliser used on these plots has been principally superphosphate at an average dressing of 1 bag per acre. A little "K" type orchard manure was used along a strip in the paddock, but has given no additional result.

The loss of grazing from these plots while they were shut up was very little more than would be experienced by sowing *Phalaris tuberosa* or perennial rye grass on a seed bed prepared after the autumn germination of clover and annual grasses had taken place.

Some lessons which may be drawn from the results to date are as follows:—

1. The preparation of a good firm seed bed is warranted in establishing perennial rye grass and *Phalaris tuberosa* in order to protect them from harmful competition. This is in the absence of a demonstration of more simple methods of establishment.

2. Good seed is necessary. South Australian certified *Phalaris tuberosa* and Clunes strain perennial rye grass have been used with success.

3. Generally, better coloured and stronger plants of these species were seen when in association with clover.

4. Deeper planting with *Phalaris tuberosa*, than that ordinarily recommended, may be used with success.

5. *Phalaris tuberosa* will suit a variety of soils and sites, but does not flourish in wet situations. Good drainage is essential.

6. Perennial rye grass is suited to the flats and lower slopes.

7. Kikuyu can be established in one season, with cuttings planted three feet apart each way, providing no grazing is allowed for that period.

8. Fertiliser applications of 1 bag of superphosphate per acre have been successful in establishing the above species.

9. Rates of sowing of 2 lbs. of *Phalaris tuberosa* and 6 lbs. of perennial rye grass have been shown to be ample, providing good seed is sown on thoroughly prepared seed beds.

10. The introduction of clover where not re-establishing itself in a *Phalaris* or rye grass paddock is advisable.

Suggestions.

The following suggestions are made for the coming season, being based on experiences of the past two seasons on those trial plots, and on other pastures in this and in other districts.

1. A longer rest from grazing would be an advantage. Some of the plots have been grazed almost continuously, and naturally this affects the depth and strength of the rooting system. Allowing the plant to make more top growth will result in (a) a greater bulk for grazing, (b) a greater reserve of plant food being built up in the root system, and so (c) allows a more rapid response after grazing. For this purpose it is suggested that the paddocks be grazed not more frequently than once in 6 weeks, but preferably not more frequently than once in 8 or 9 weeks.

2. In establishing *Phalaris tuberosa* the following methods are worthy of trial. (a) Sowing in the early autumn, on to the damp layer of fallow, prepared in the previous spring. This should result in early germination of the *Phalaris* and its establishment beyond the delicate seedling stage before germination of the annual species present can result in smothering competition. (b) Sowing on the "burn," that is, into the seedbed formed by ashes after a fire. Several small patches of *Phalaris* have been inspected which have been sown into the ashes of burnt logs and hay stacks.

3. Eastern States experience has followed closely that in this State, where perennial rye grass has been sown on to a pasture which has been scarified. The competition from the annual pasture types has been too severe to allow the new plants to thrive. Hence the necessity for destroying this competition by preparing a firm seed bed and, in doing so, retarding the development of the annuals. Further Eastern States experience has showed to advantage, another more simple method which has the advantage of not destroying the grazing in a paddock for any period, in contrast to the full seed bed method, where the paddock is practically of little use for one year at least. In the method referred to above, the seed is sown through the drill with the discs or hoes penetrating the moist soil to a depth of 1 to 1½ inches. The work should be carried out when the soil is only sufficiently moist to scatter freely from the discs carrying with it any seeds which may have been present. This results in a series of drills through the paddock, where no annual seeds are present. The rye grass seed is deposited here and is able to ger-

minate and reach several inches in height before the annual plants can reach across and smother them. Once they are past the first two or three inches, the competition from other plants will not do much damage.

The competition will conclude with two inspections carried out during 1939, one in May and the second in October.

THE IMPERIAL BUREAU OF DAIRY SCIENCE.

In 1936 the British Commonwealth Scientific Conference which met in London to consider the working of the organisations controlled by the Executive Council of the Imperial Agricultural Bureaux, recommended that a new Imperial Bureau of Dairy Science be established. The conference also suggested the National Institute for Research in Dairying as the most suitable location for the Bureau.

Following agreement by all the authorities concerned, the new Imperial Bureau of Dairy Science has now been established at Shinfield, near Reading. Prof. H. D. Kay, O.B.E., Ph.D., D.Sc., Director of the National Institute for Research in Dairying, has been appointed Director of the Bureau. Mr. W. G. Sutton, M.Sc., A.I.C., from Massey Agricultural College, New Zealand, has been appointed Deputy Director and has now taken up his duties. The Bureau is financed co-operatively by the Governments of the British Empire in the same way as the other Imperial Agricultural Bureaux.

The functions of the Bureau are to index research work in dairy science, whether carried out in the Empire or elsewhere; to collect, abstract and collate information bearing on dairy science and to distribute such information, both by publication and by private communication to research workers, officials, and advisory officers throughout the Empire. In addition, the Bureau is charged with the duty of establishing and maintaining contact between research workers with common interests, promoting conferences of workers and visits to research centres, and in general encouraging the circulation of information, ideas, material and personnel.

The field of dairy science to be covered by the Bureau was defined by the Conference when recommending its establishment. This field includes the microbiology, chemistry, and physics of milk and its products; animal diseases in so far as they affect milk and its products; the technology of processing milk and manufacturing dairy products; the physiology of milk secretion as affecting quality and quantity of milk and dairy products; standards for the composition and quality of milk and its products.

The routine duties of the Bureau, such as indexing and abstracting, will already be familiar to many dairy workers from the activities of the Bureaux already established in other subjects. An aspect of Bureau work which may not be so well known and understood is the more informal service which can be given to research workers, teachers, and field officers. The Bureau aims to be the friend of these dairy workers. The Bureau will deal directly with the individual workers in dairy science, who are invited to write to the Bureau for information which is not obtainable in their own countries. The Bureau may be able to supply the information itself, or to put the inquirer in touch with someone who can do so more effectively.

The new Imperial Bureau of Dairy Science has been established in answer to requests for a clearing house for information in dairy science; its value to dairy science, and to the dairy industry generally, will largely depend on the extent to which research workers and others avail themselves of its services.

TOBACCO GROWING IN WESTERN AUSTRALIA.

A. SHARP,
Tobacco Adviser.

The history of tobacco cultivation in Western Australia on a commercial scale dates only from about 1930. Prior to that date attempts to produce marketable leaf had been made, but the small areas planted could be regarded as being more or less of an experimental nature. During the 1930-31 season 25 acres were cropped for a yield of 12,500 lbs. of cured leaf. From then on the area planted steadily increased until in 1937-38 an area of 1,215 acres was cropped for a total yield of 854,000 lbs. Coincident with the increase in production, the quality of the leaf has steadily improved until it is now recognised as being second only to North Queensland leaf. Over the last few years the State yield has averaged approximately 700 lbs. per acre of cured leaf and individual crops have frequently yielded 1,000 lbs. per acre and over—figures which compare very favourably with other tobacco-producing districts in the Commonwealth.

The industry is located almost entirely in the Manjimup district in the lower South-West of the State. Various attempts to produce leaf of acceptable type in other districts have so far met with indifferent success.

Climate.

It is generally recognised that a suitable climate is the first essential for the production of good tobacco. The ideal conditions for the growth and proper maturing of the tobacco plant are abundant and evenly distributed rainfall, high temperatures, high humidity, a fair amount of cloudy weather, and absence of hot, drying winds. Climatic conditions at Manjimup differ considerably from this ideal. While the average annual rainfall of 42 inches is about equal to that of the tobacco-growing areas of America, it is not evenly distributed, only about 5 to 6 inches being usually recorded during the five months October to February, inclusive. The months of December, January and February, during which the tobacco crop is maturing and being harvested at Manjimup, are usually characterised by very dry, hot, sunny weather, low atmospheric humidity, and absence of cloud. In addition, hot dry winds during the day and sharp falls of temperature at night are occasionally experienced. It will thus be seen that the West Australian tobacco grower has to contend with weather conditions which are by no means ideal, and if he is to produce the type of leaf demanded by the manufacturers he must take great care that the location of his crop and his cultural practices are such as to offset as far as possible the effect of the rather harsh summer weather usually experienced.

Soils.

The second factor, which is recognised as playing an extremely important part in the production of good quality tobacco is soil of the right type. Generally speaking, the bright flue-cured tobacco of mild, sweet-smoking quality which is in greatest demand to-day can be grown best in light sandy or sandy loam soils of comparatively low fertility. There are quite large areas of soil answering this description in the Manjimup district, and where such soils occur in well-sheltered valleys in association with a clayey subsoil at about 18 to 30 inches depth, they appear to be able to retain sufficient moisture throughout the dry summer months to bring excellent crops of tobacco to maturity without the aid

of irrigation. With the exception of one or two favoured areas, crops grown on hillside land usually suffer considerably from drought, do not mature normally, and yield only a small proportion of bright leaf. Intending growers would be well advised to exercise the greatest care in the selection of suitable areas for tobacco culture. It will usually be found that only a comparatively small proportion of the total area of any particular farm is suitable for this crop.

The Tobacco Plant.

The tobacco plant of commerce (Nicotiana tabacum) belongs to the Natural Order Solanaceae, to which also belong the tomato and potato. It is an annual plant and is propagated in seed-beds and set out in the field when about four inches high. It is a summer-growing plant, being usually planted out in October and harvested during January and February. On harvesting, the leaf is subjected to a curing process, during which a large proportion of the natural moisture is extracted. A number of different methods of curing are in use in various countries, and each method produces tobacco of distinctive type and smoking characteristics. By far the largest demand in Australia at the present time is for leaf of bright colour, fine texture and of mild smoking quality, suitable for cigarette and fine cut tobaccos. This type of leaf is obtained from certain varieties which are suitable for flue-curing. Practically the whole of the tobacco produced in Australia at the present time is flue-cured.

Selection and Preparation of Tobacco Land.

As already explained, the careful selection of land for tobacco growing is extremely important. The present state of our knowledge is insufficient to allow us to say definitely whether any particular area will produce good tobacco or not without actual trial, but a few points may be mentioned as a rough guide. The soil should be a free working sandy loam, either grey, brown, or red-brown in colour. Black sand or peaty soil should be avoided. The greatest essential is that it should be capable of retaining moisture throughout the summer. Previous knowledge on this point is of great assistance in selecting land, but if this is lacking the nature of the subsoil is a fairly reliable guide. A yellow or brown mottled clay or clay loam at a depth of 18 inches to 2 feet can generally be taken as a good sign. Many good tobacco soils contain a proportion of gravel, but very gravelly soils should be regarded with suspicion. The most suitable soils are usually found on gentle slopes and flats between the heavily timbered ridges which are a prominent feature of the local topography. Where the native vegetation, which consists of karri or jarrah in association with redgum (marri), has been allowed to remain untouched on the ridges, protection from wind is afforded. Generally speaking, newly cleared land of suitable type yields very satisfactory crops, both as regards quantity and quality. Land which has been under clover pasture for a number of years, however, usually gives very poor results. The accumulated fertility of such soil, particularly the large amount of organic nitrogen stored by the clover roots, has a disastrous effect on the quality of the tobacco and may render the leaf practically uncurable. Where it is desired to utilise old clover land for tobacco, a non-leguminous crop such as oats, turnips or maize should first be grown in order to remove the excess nitrogen.

The heavy winter rainfall experienced at Manjimup causes a good deal of waterlogging of the valley soils. Where the excess water does not drain off fairly rapidly with the advent of finer weather in the early spring, the necessity for artificial drainage is indicated. Tobacco will not do well on badly drained land, and the leaf produced is of poor burning quality.

Preparation of the land for tobacco should begin in the autumn. It should be ploughed deeply in April or May as soon as the autumn rains have moistened it sufficiently and germinated any weed seeds that may be present. Surface drainage will be assisted where necessary by ploughing in fairly narrow lands and leaving a fairly deep finishing furrow between each land. Where it is not considered necessary to grow a green manure crop, the ground may be left without further cultivation until the following August, when it is again ploughed and cultivated until a fine tilth is obtained. The benefits to be obtained from autumn ploughing are very considerable, but they are not fully realised by many tobacco growers. In the case of newly cleared land, the turning over of the soil exposes it to the sweetening action of sun, wind and rain, while on old land weeds and overwintering insect pests are effectively checked by winter fallow.

Green Manuring.

The soils of the Manjimup district are naturally poor in humus. This is a distinct disadvantage, inasmuch as the tobacco plant grows best in a soil in which there is a good supply of decayed vegetable matter. Fortunately, it is within the power of the farmer to rectify this deficiency by growing and ploughing in suitable green manure crops. Such crops may be divided broadly into two classes, viz., leguminous, such as field peas and lupins, and non-leguminous, such as oats and rye. The former, owing to the property they possess of supporting colonies of nitrogen-fixing bacteria in nodules on their roots (provided the requisite bacteria are either present in the soil or are introduced thereto with the seed itself by natural or artificial means), not only enrich the soil in humus when ploughed in, but add materially to the supply of nitrogen. Non-leguminous crops, on the other hand, are quite incapable of adding fresh nitrogen to the soil.

As already mentioned, it is undesirable to have tobacco soils too rich in nitrogen, therefore the growing of wholly leguminous crops for green manuring is not recommended. Excellent crops of tobacco have, however, been grown after mixed crops, such as oats, or rye, together with field peas, have been ploughed in. In the past, large areas at Manjimup have been successfully cropped annually with tobacco for a number of years, the soil being kept in good condition by growing green manure crops during the autumn and winter and ploughing them under in the early spring. While it is recognised that such continuous cropping is open to serious objection, principally from the point of view of disease and insect pest control, and hence cannot be pursued indefinitely, yet the results already obtained from this system have demonstrated the great benefits to be obtained from the practice of green manuring.

Varieties.

A large number of varieties have been tested in the Department's field experiments at Manjimup during the last five years. The results obtained from these, together with the experience of commercial growers, indicate that the following varieties are capable of producing good crops of excellent quality leaf in this State.

"Hickory Pryor."—This has been regarded as the standard variety for a number of years. It is a good yielder of very good quality leaf where grown under really good conditions, but in some situations it tends to produce a rather coarse leaf, somewhat narrow in proportion to its length, particularly at the top of the plant, and is rather difficult to cure a really bright colour.

"Cash."—This variety is very similar to "Hickory Pryor" in appearance, though of slightly taller habit. Over a period of five years it has yielded slightly

heavier crops than the latter in the Departmental experiments. It is comparatively easy to cure and generally yields a high proportion of bright leaf.

"Kelly."—This variety was imported from New South Wales by the Department for experimental purposes three years ago. It proved an immediate success and is already threatening to oust "Hickory Pryor" from its position as favourite with growers. It prefers the moister types of soil and on these it produces a heavy crop of high quality leaf. The leaf is broader in proportion to its length than either "Hickory Pryor" or "Cash," and is easy to cure.

Leaf of these three varieties is acceptable to Eastern States manufacturers.

"Sport."—This variety was evolved at Manjimup some years ago by Mr. H. J. Limmer, Plantation Manager to Michelides, Ltd., of Perth. It has proved itself remarkably well adapted to local conditions and yields consistently heavy crops of bright leaf. It requires less suckering in the field than most other varieties and is easy to cure. It would be extremely popular with growers were it not for the fact that the smoking quality of the leaf is not altogether acceptable to Eastern States manufacturers, who state that they are not prepared to purchase it in large quantities. In view of this fact, growers who intend producing for the Eastern States market are recommended not to plant this variety.

Several other varieties tested by the Department gave very promising results during the 1938-39 season. These include "Gold Dollar," "Yellow Mammoth," and "White Mammoth." It is inadvisable to accept the results of only one season as conclusive, however, and growers are recommended to plant only the better-known varieties until the newer ones have undergone further trial.

(To be continued.)

LUCERNE COMPETITION.

M. CULLITY, Senior Agricultural Adviser.

In conjunction with the Pasture Competition, the Donnybrook Dairy Farmers' Association conducted a lucerne competition, which was sponsored at the suggestion of Messrs. Dempster and W. E. Hearman. As with the pasture competition, this was divided into two sections, one dealing with the preparation of the seed bed, and the other with cultural operations and growth.

The seed bed inspection resulted as follows:—

Name of Farmer.	Fineness and Freedom from Clods.	Freedom from Weeds.	Consolidation.	Total
Maximum Points	40	30	30	100
Frost, A. C.	40	24	28	92
Langridge, B.	38	26	27	91
Cunningham, C. J. ..	38	25	27	90
Brockman, R. T. D. ..	35	29	25	89
Hearman, J.	36	27	25	88

Inspections of the plots were carried out when inspecting pastures, and the points allotted for 1938 are as follows:—

Name of Farmer.	Evenness, Vigour, etc.	Weeds, etc.	Insects and Disease.	Bulk.	Total.	Grand Total.
Maximum Points ...	30	20	10	40	100	200
Brockman, R. T. D.—						
May	18	8	10	30	66	...
October .. .	15	13	7	36	71	137
Frost, A. C.—						
May	22	7	10	25	64	...
October . .	18	10	7	35	70	134
Langridge, B.—						
May . .	20	10	10	20	60	..
October	16	12	9	28	65	125
Cunningham, C. J.						
May	14	7	10	18	49	..
October .	8	10	9	25	52	101

Unfortunately we must record that the conditions as seen during the inspection in October indicate that only two of the plots will be successful. Reasons for this are as follows:—

Plot 1.—Seedlings were destroyed by red mite attacks.

Plot 2.—Competition from couch grass has prevented the plants from obtaining good development, and next year's growth will be reduced.

Plot 3.—Was quite successful in establishment, but rabbit attacks are gradually reducing the number of plants. These pests eat the crown of the roots, and so totally destroy the plants.

The two leading plots, however, do indicate what a valuable plant lucerne can be under conditions which cannot be described as the optimum. The particulars of the plots are as follows:—

Brockman, R. T. D.

The soil is a sandy loam situated on the slope above the Preston river, and carried originally a mixture of jarrah and redgum. A crop of potatoes was taken off the land in the spring of 1936. The land was ploughed during the succeeding summer, and sown with rape which was grazed off during the autumn and winter. The land was again ploughed and harrowed in August, and the operations repeated. The seed and manure were drilled in as shallow as possible, after rolling, and finally a stroke of the harrows was given. Seed was sown at the rate of 6 lbs. per acre. Inoculation of the seed with bacteria was carried out; one bag of super per acre was applied. Harrowing was again carried out when the plants were 3 inches high, and once again during the summer months in order to check weed growth and retain a mulch. After the first rains in the autumn the paddocks were cross cultivated (using a springtyne) to a depth of 2 to 3 inches. A further application of one bag of super was made. The attacks of rabbits were responsible for the destruction of a number of the plants, but reseeding of the bare patches rectified this. The lucerne plants appeared very healthy, and weeds were very few, apart from some bracken. Later in the spring weed attack was more serious, cape weed and cluster clover being present. The lucerne plants, however, had made splendid progress, and a heavy crop of hay was cut from the paddock.

Frost, A. C.

This paddock was cleared several years ago, and has been used for pasture. It is situated on the bank of the Preston river, but on a considerably higher level. Much couch grass and subterranean clover were present in the pasture. A crop of oats was sown in the 1936 season. The paddock was ploughed in January, 1937, one ton of agricultural lime applied and turned in during May, and a cultivation and harrowing carried out twice during the winter. Cultivation with a Sunpalm renovator was carried out in early September. Five and one-half bags of super were applied over 3 acres, and the paddock was then rolled and again harrowed. Two days later inoculated seed was sown broadcast at the rate of 10 lbs. per acre. After sowing, one half of the paddock was rolled and the other half harrowed. Good germination resulted from the whole plot, and a further stroke of the harrows was given at the end of November in order to conserve moisture. The plants were topped when about 9 to 12 inches high. In May, 1938, it was seen that the competition from couch was going to weaken the stand, but at that time a very useful crop had been obtained. The plants were fairly even, and were up to 18 inches in height. Grazing had been carried out with a herd of 15 cows for 4 days for one hour each day, prior to the inspection. Following the inspection the grazing was continuous until the crop was reduced to about 6 inches. A really good crop was cut for hay in the late spring.

Further inspections will be carried out during this season (1939).

AGRICULTURAL PROBLEMS.

Agriculturists, pastoralists and primary producers generally, who may be having difficulties of any kind in connection with their production activities, are invited to communicate with the Agricultural Adviser of their district of the Department of Agriculture, when information and advice will be supplied free of charge.

Where identification of plant or stock diseases or insect pests is required, full details of symptoms should be forwarded and also samples of the diseased plant, animal tissue or insect where practicable. Plant tissue intended for examination by the Plant Pathologist should be wrapped in paper and not forwarded in airtight containers, and plant specimens for the Botanist should be pressed between newspaper and dried before despatch. With regard to animal tissue for microscopic examination, this should be forwarded in a solution of 10 per cent. formalin, or if of considerable bulk in a sealed kerosene tin containing a few ounces of formalin as a preservative. Living insects should be sent in suitable containers and dead specimens in methylated spirits.

The addresses and names of Advisers are as follows:—

Albany	**H. R. Powell (Fruit); B. Williams (Dairying).**
Bridgetown	**A. Flintoff (Fruit); A. M. Tindale (Dairying).**
Bunbury	**M. Cullity.**
Geraldton	**N. Davenport (Government Buildings).**
Gosnells	**R. C. Owen.**
Harvey	**R. L. Cailes (Fruit).**
Katanning	**A. S. Wild.**
Kalamunda-Roleystone	**W. H. Read, c/o. Department of Agriculture, Perth.**
Kununoppin	**W. M. Nunn.**
Manjimup	**C. M. Scott.**
Metropolitan, Gingin, Chittering ...	**S. E. Bennett, c/o. Department of Agriculture, Perth.**
Mundaring	**V. Cahill.**
Narrogin	**A. T. Gulvin.**
Vasse	**J. M. Nelson.**

A SOIL SURVEY OF THE DENMARK AGRICULTURAL RESEARCH STATION, DENMARK, WESTERN AUSTRALIA.

G. H. BURVILL, Agricultural Adviser.

FOREWORD.

Soil surveys are designed to collect and collate information regarding soils, and essentially involve the recognition, description and mapping of the soil types of any area under examination. On account of soil variability, and the numerous factors interacting in soil formation, soil surveys are necessarily on a broad basis, and boundaries between soil types are usually not sharp. Furthermore, so many factors affect plant growth that a perfect correlation between soil type and crop returns cannot be expected. The value of the soil survey lies in the systematic, if general, description of the soils of an area and their classification on the basis of such recognisable features as profile—the colour and texture (heaviness, etc.) of the layers exposed when a hole is dug—drainage, underlying rocks, vegetation associations, topography, etc. These features all affect plant growth or reflect fertility levels, so that such a classification represents an addition to knowledge of soil conditions which, when interpreted, will facilitate and rationalise agricultural development. Even the broad land classification carried out by surveyors made possible systematic land settlement in Western Australia in the face of natural difficulties, and there is no reason to doubt that the more modern soil survey will make a further substantial contribution to efficiency in Western Australian agriculture.

The Department of Agriculture, in association with other organisations, has been engaged on soil surveys in Western Australia over the last 10 years, and has mapped over 1,250,000 acres in detail with respect to special problems such as soil salinity and nutritional disorders of stock. The information collected is being published as rapidly as possible as a basis for future work—that of interpretation in terms of agricultural practice.

The agricultural areas of Western Australia cover approximately 70,000,000 acres. It would obviously be impossible to subject the whole of this huge area to a detailed soil survey in a reasonable time so that, as a step in the direction of diagnosing and elucidating soil problems, "spot" surveys are being made of representative sections throughout the agricultural portion of the State. By this means, and by assuming that a few thousand acres represent a district of 100 times that area, a body of valuable information will be gathered as a basis for experimental and advisory work. A number of "spot" surveys have already been undertaken in connection with various soil problems in several districts, and the soil survey of the Denmark Research Station by Mr. G. H. Burvill represents one of these. It is published as a record of the soil conditions on a farm being used for research purposes for the benefit of the south coastal areas.

L. J. H. Teakle.

SUMMARY.

A soil survey has been made of the Denmark Agricultural Research Station comprising 210 acres of land adjoining the Denmark River.

Fourteen soil types, exclusive of alluvial areas, undifferentiated wet soils and river sandbanks have been recognised, described and mapped. Of these, nine are types recognised in a larger district survey, while the remaining five are new types.

The soils have been grouped on the basis of profile features, reaction, parent rock, drainage, etc., into three main groups, with several ungrouped soils. Group I. soils are grey, yellow, and light brown sands more or less gravelly, with yellow to white clay subsoils. The pH of the surface soil is 5.5-6.0. Group II. soils are well podsolised grey sands, with "coffee rock" or ferruginous hardpans or coffee-stained layers in the subsoil; the surface pH is 4.4-4.8. Group III. soils are chocolate, dark grey and brown loams with clay subsoils, and are formed over basic rocks. The surface pH is about 6.

The relationship of the soil types to pasture development is briefly discussed. While considerable success has been achieved in pasture establishment on the soils of Groups I. and III., the soils of Group II. present special difficulties which are now being investigated. Group II. soils occur extensively in the Denmark and surrounding districts under a natural vegetation of stunted jarrah or scrub heaths of kangaroo "grass," bottlebrush, teatree, etc.

INTRODUCTION.

The Denmark Agricultural Research Station, formerly known as the Denmark stud farm, now comprises about 210 acres of land adjoining the Denmark River and lying north-east of, but close to, Denmark township. It was established in 1912 after a visit to the district of the Hon. T. H. Bath, then Minister for Agriculture, who decided that a demonstration and experimental dairy farm should be established to impart practical information to farmers of the district in dairying and its allied branches. The original farm taken over from the Lands Department comprised only about 27 acres on the right bank of the river; this piece surrounds the farm buildings but forms only the south-west corner of the present station. Additions of land were made from time to time till the station reached its present area in 1927.

In addition to studying the general problems of pasture and fodder production and conservation, an important function of the Research Station has been the maintenance of a herd of pedigreed Guernsey cattle and the breeding of pedigreed Berkshire and Tamworth pigs. In the earlier years small butter and bacon factories were also in operation at the Station.

CLIMATE.

The climatic features of the Denmark district have been discussed in some detail by Hosking and Burvill (1938) in C.S.I.R. Bulletin No. 115, "A Soil Survey of part of the Denmark Estate." The annual rainfall is 48 inches, of which about three-quarters falls in the May-October period, but no month of the year has an average of less than one inch. Temperatures are mild even in the summer months and winter frosts are uncommon.

NATURAL VEGETATION.

Prior to clearing, the main vegetation associations of the Denmark district seem to have been represented on the Research Station. Karri (*Eucalyptus diversicolor*) forest associations appear to have predominated in the south-western parts, while jarrah (*E. marginata*)—marri (*E. calophylla*) associations, and wet heath associations, including bottlebrush and kangaroo "grass," with scattered paperbark and blackbutt, occur on the eastern and northern sections. Further details are given in discussing the individual soil types.

PHYSIOGRAPHY AND GEOLOGY.

The highest parts of the Station are along its eastern and north-eastern boundaries whence drainage west to the Denmark River follows three main creek courses.

Slopes are mostly quite gentle compared with some parts of the district. No elevations have been determined east of the river, which is here close to sea level, but the highest point is probably not above 200 feet. The river course is well defined in most places by steep banks rising in places to about 15 feet above summer level, so that only small areas of the Station are liable to winter flooding by the river.

Several interesting features of the geological history of the area have been revealed by the soil survey. As in the district to the west, most of the outcropping rocks are either acidic and gneissic or of a basic, igneous character, and with them, certain soil types are usually associated (see later). However, rounded quartz gravel was frequently found in the upper sandy layers in soils of several types, especially in the north-east of paddock 14, the south-west of paddock 18, and to the south of the creek in paddock 17. This gravel was up to an inch long and occasionally of greater size. In the north-east of the Station an area of deep sandy soil of the Willbay series was found to contain much well rounded, as well as more angular, quartz grit, up to about ¼ inch in size, from near the surface to a depth of eight feet. Such occurrences, which appear to be deposits of transported materials, must be an important guide to the geological history of the area, and further, they indicate the complex character of the parent materials of the soils. This is discussed more fully in the next section.

Ferruginous laterite gravel and some boulders are associated with several soil types, but no areas completely covered with massive laterite boulders occur. The gravel pit near the west side of paddock 18 shows rounded quartz gravel among the more common ferruginous laterite gravel. Some of these rounded quartz pieces are cemented into ironstone lumps which appear to have been formed by a secondary cementation of the gravel deposits. The ferruginous gravels occurring in various soil profiles are not uniform in character. When found in the surface layers in types such as the Wakundup very gravelly sand and the Koorrabup very gravelly sand, they are usually fairly smooth in outline and do not appear, on breaking, to contain much quartz sand. On the other hand, ferruginous gravels from subsoil layers are very irregular in shape and often include much quartz sand. It is thought that these latter gravels may be the result of pedogenic processes under the present climatic conditions, while much of the surface gravel may be residual from a former climatic cycle and has been exposed by subsequent land movements and geological erosion.

DESCRIPTION AND CLASSIFICATION OF THE SOILS.

General.

The soil survey of about 16,000 acres in the Denmark district reported by Hosking and Burvill (1938) in C.S.I.R. Bulletin No. 115 was used as a background for the classification of the soils of the Research Station. A number of the soil types recognised in the larger survey occur on the Research Station, though in some cases they show variations from the general type description which makes it desirable to consider them as specific phases. Further, five new series designated B, C, D, E, and F, which were not recognised in the district survey, have been mapped on the Research Station, the survey of which was on a more intensive basis and thus allowed more attention to be given to soil variations which may have been submerged in the more inclusive groupings of a broader survey.

Fourteen soil types, exclusive of alluvial areas, undifferentiated wet soils and river sand banks have been mapped, principally on the basis of soil profile features. The order of the following descriptions is intended to bring out relationships between the types. Further, they have been divided into broad groups on the basis of certain general similarities, and it is likely that methods for pasture establish-

ment and management will be generally similar for the types within each group. The extent of each of the soil groups, types and phases is given in Table 1.

TABLE 1.

AREAS OF SOIL TYPES MAPPED ON DENMARK RESEARCH STATION.

Soil Type.	Symbol.	Area.
Group I.—		acres.
Wakundup very gravelly sand	Wvgs	7·5
Wakundup gravelly sand grey phase	Wgs	6·2
Wakundup gravelly sand brown phase	Wgs	17·1
Type B loamy sand	Bls	10·0
Type C sand	Cs	16·7
Koorrabup very gravelly sand	K^{o}vgs	3·7
Koorrabup gravelly sand	K^{o}gs	8·9
Group I. Subtotal		70·1
Group II.—		
Kordabup sand	K^{b}s	11·9
Kordabup sand hardpan phase	K^{b}s/$_{H}$	8·2
Kwilalup sand	K^{w}s	28·5
Type D sand	Ds	11·2
Plantagenet peaty sand	Pps	41·5
Willbay sand	W^{b}s	6·5
Group II. Subtotal		107·8
Group III.—		
Koorundurup gravelly loam	K^{r}gl	3·1
Type E gravelly loam	Egl	6·8
Group III. Subtotal		9·9
Ungrouped—		
Type F sandy loam	Fsl	11·9
Alluvial soils	A	5·5
Undifferentiated wet soils	U	2·5
River sandbanks	....	1·6
Rock outcrops	....	0·7
Total (acres)	....	210·0

These areas include the land between the surveyed river traverse and the river's edge, also the closed east-west roads in paddocks 16 and 20, but the north-south surveyed road through the Research Station is excluded.

The complexity of the soils on the Research Station must be in part attributed to their association with the Denmark River, the course of which has undoubtedly changed as geological erosion has progressed towards the present topography. Deposits of alluvial and colluvial origin have formed the parent materials of types C and D and possibly F, as well as the more recent alluvial areas mapped A.

As previously mentioned, acidic gneissic rocks and also basic igneous rocks outcrop in various places along the river banks and away from the river. With the acidic rocks, soil types such as the Wakundup gravelly sand, the Koorrabup gravelly sand and a new type B loamy sand are associated, while over the basic rocks occur the Koorundurup gravelly loam and a redder soil (type E gravelly loam) showing some relationship to the Scotsdale soils. It might be thought that such soils have developed from the weathering in situ of these rocks, but the occurrence of rounded quartz gravel and grit in several soil types reveals the importance of transported materials in this area. It seems probable, therefore, that even types such as the Wakundup gravelly sand, the Koorrabup gravelly sand and the Kordabup sand, which have yellow clay subsoils at about two feet, and show signs of decomposing gneissic rock at about four feet, may have their surface sands derived partly—even largely—from transported sands, rather than from the weathering in situ of such basal rock.*

Details of the Soil Types.

Group I.

Grey, yellow and light brown sands, more or less gravelly, with yellow to white clay subsoils. Originally timbered with karri and/or jarrah and marri.

Types Mapped.

Wakundup very gravelly sand ...	Wvgs
Wakundup gravelly sand grey phase ...	Wgs (hatched)
Wakundup gravelly sand brown phase .	Wgs
Type B loamy sand	Bls
Type C sand	Cs
Koorrabup very gravelly sand ..	K°vgs
Koorrabup gravelly sand	K°gs

In this group the surface soils are slightly to moderately acid with a pH range of 5.5-6.0. The subsoils are of similar reaction generally but type B loamy sand showed a very acid subsoil and deep subsoil. (See Table 3.)

Wakundup Series.

This series, whose soils are very extensive in the district and most widespread of the developed karri hill soils, is represented on the Research Station by both its recognised types, the ***Wakundup gravelly sand*** (Wgs) and the ***Wakundup very gravelly sand*** (Wvgs). Both the grey and brown phases of the former occur and conform closely to the type descriptions given by Hosking and Burvill (1938) in C.S.I.R. Bulletin No. 115, *i.e.,* their profiles show grey, yellow grey and light brown

* This view is supported by mineralogical examinations of subsurface and subsoil samples made by Dr. Dorothy Carroll, Department of Geology, University of W.A. The fine sand fractions of the subsurface samples from profiles of Koorrabup gravelly sand and type B loamy sand. were made up principally of rounded and subangular grains, while in the clay subsoils the grains were largely angular and subangular, and larger angular quartz pieces belonging to the weathered bedrock occurred. In one profile studied there was a smaller assemblage of heavy minerals in the subsoil than in the surface. Since the underlying rock is probably a gneissic granite, the rounded grains in the upper layer of the profile and the mineralogical composition of that layer indicate that it is probably transported.

loamy sands, with more or less laterite and quartz gravel, passing at 18 to 24 inches usually to yellow "short" clay. Outcrops of acid gneissic rock are associated with several areas of this type. The Wakundup very gravelly sand occurs along the Scotsdale Road boundary, and on the high land in the central part of the Station. The yellow to light brown very gravelly sand is over 3 feet deep in many places, and laterite boulders are fairly common in the soil and around trees. Quartz grit was found to occur in a layer above the yellow sub-soil clay in some places, and rounded quartz gravel was also noted in the gravel pit in paddock 18.

The Wakundup soils are mostly cleared but appear generally to have supported a karri-marri-buloke (*Casuarina decussata*) vegetation association. Jarrah is known to have grown on a few areas mapped in this series.

Type B loamy sand (Bls).

This type is characterised by a subsoil of white or pale yellow "short" clay with a talc-like feel which seems to have developed from a very acid gneissic rock. The overlying soil, which is generally 20 to 30 inches deep, rather resembles the grey phase of the Wakundup gravelly sand. Below 4 to 6 inches of grey loamy sand with organic matter, a grey to yellow grey loamy sand or sandy loam occurs with varying amounts of quartz gravel. A grey brown soft gravel of low density occurs in some profiles, and small light brown concretions with a charcoal nucleus also occur in the surface layers. Grit and gravel are usually most dense in a layer of several inches above the subsoil clay which, if not light grey or white when first encountered, becomes more white and short and "talcy" with depth. Decomposing rock has been found below 3 to 4 feet and also observed at the well on the hilltop in the main area of this type. The deep subsoil layer (42in.-60in.) where sampled was strongly acid (pH 3.98).

The main occurrence of type B is in the central parts of the station associated with the Wakundup soils, though it has been vegetated by a jarrah-marri association, not with karri. Observations after 7 inches of rain in January, 1939, and statements from others, indicate that this soil becomes more or less waterlogged in winter, presumably through seepage from the areas of Plantagenet peaty sand which lie to the east of it and at somewhat higher elevations.

Type C sand (Cs).

In appearance this type also seems to have affinities with the Wakundup soils, but most often no clay horizon was found within 42 inches of the surface. The location of the mapped areas suggests that colluvial and alluvial deposits adjacent to the river and creeks, or at the foot of slopes, have formed the parent materials of the type. The profiles show grey, yellow grey, yellow, light brown, and occasionally brown sands or loamy sands mostly more than 42 inches deep and, as usual, the surface layers show some darkening by organic matter. Gravel is often absent or occurs deep in the profile below 27 inches. Yellow sandy clay loam or sandy clay was found below 30 inches in some places. The area adjoining the river in the western part of paddock 20 occurs as a number of ridges with several moist hollows between, and represents old river sandbanks, now well above river level. The clay beneath the sand at the foot of one ridge, and also in a moist hollow, was a grey sticky plastic clay under which a sand layer was found in one boring, suggesting alluvial origin.

A timber association of well grown jarrah and marri was the native vegetation of some areas of this type, while in other cases karri has grown on these soils.

Koorrabup Series.

The two recognised types of this series (see C.S.I.R. Bulletin No. 115) have both been mapped on the Research Station, but as specific cases. The *Koorrabup gravelly sand* (Kogs), a common type in the district under jarrah-marri vegetation associations, occurs principally as a *deep phase* with only a little ferruginous gravel. Instead of about two feet of yellow sand, more or less gravelly, overlying a yellow or yellow brown clay, the sand was mostly over 3 feet deep with gravel confined to its lower parts. A type sample from paddock 20 showed the usual yellow clay (with gravel embedded in it for a few inches) at 4 feet. The clay became mottled yellow, red brown, and white with depth, and gritty decomposed rock and clay were found below 5 feet.

The *Koorrabup very gravelly sand* (Kovgs), of which the A horizons of yellow to light brown very gravelly sand are usually over 2 feet deep, occurs in paddock 20 as a *shallow phase* with clay at 12 to 15 inches. The gravel is principally ferruginous (laterite) but some quartz pieces were also noted. The Koorrabup types resemble rather closely the Wakundup gravelly sand, brown phase, and the Wakundup very gravelly sand, though the A horizon sands are usually more yellow in the Koorrabup types and rather brownish in the Wakundup soils. A well grown jarrah-marri, *Banksia grandis* association is characteristic of the Koorrabup soils.

Group II.

Includes well podsolised grey sands with "coffee rock" or ferruginous hardpans or coffee stained layers in the subsoil. Vegetation varies from well grown or stunted jarrah-marri associations to open wet heath associations of bottlebrush, kangaroo "grass," rushes, stunted blackbutt and paperbark.

Types Mapped.

Kordabup sand .	K^bs and $K^bs/_H$
Kwilalup sand .	K^ws
Type D sand	Ds
Plantagenet peaty sand	Pps
Willbay sand	W^bs

These soils are generally the most acid soils of the area, the surface soil averaging about pH 4.6, compared with pH 5.6 for the soils of Group I. and pH 6.0 for the types of Group III.

Kordabup Sand (K^bs *and* $K^bs/_H$).

This type, like the Koorrabup soils, carries a jarrah-marri vegetation association in its virgin state, but its profiles, while grading into those of the Koorrabup gravelly sand, are typically well podsolised. Two phases, a *variable hardpan phase* and a *well developed hardpan phase* are described in C.S.I.R. Bulletin No. 115. and both occur on the Research Station in conformity with those descriptions. Quartz grit and gravel and ferruginous gravel occur in varying amounts especially in the variable hardpan phase. The area in paddock 14 has a large amount of rounded quartz grit and gravel in the sandy layers, clearly indicating that these layers must be transported materials.

Kwilalup Sand (K^ws).

This soil type occurs fringing the open kangaroo "grass," bottlebrush, paperbark areas of the eastern part of the Station, and also on the slopes between the Koorrabup gravelly sand and the river in Paddock 20. It is a well developed

podsol with a dark brown "coffee rock" hardpan of variable thickness, commencing usually 18 to 24 inches below the surface. Profiles of this type grade into those of the Plantagenet peaty sand, where, however, coffee rock, if it occurs at all, is usually below 36 inches. There is also a relationship to type D (see below).

The surface soil of the Kwilalup type is sand with sufficient organic matter to impart a grey to black colour somewhat darker than in the Kordabup sand. This passes gradually to grey or light grey sand in the A_2 horizon. Below this more or less bleached layer, but above the coffee rock proper, a soft brownish black cement, probably organic, occurs in some profiles as a layer one to two inches thick. The coffee rock, which may be up to a foot in thickness, is dark brown (coffee coloured) at first, but becomes more yellow and gritty with depth. In some cases it passes directly on to yellow clay, but in other profiles about a foot of yellow sand or clayey grit occurs below the coffee rock before clay is reached. In a type sample boring, yellow plastic clay underlay the coffee rock, then yellow, red and grey mottled clay which passed into sandy clay below 4 feet and clayey sand at 6 feet. Below this was light grey fine sandy clay. This succession of layers of variable texture suggests again the importance of deposits of transported materials as parent materials of some, at least, of the Denmark soils.

Other details of the Kwilalup sand are given in C.S.I.R. Bulletin No. 115. The vegetation on this type consists of stunted jarrah and marri, odd paperbark (*Melaleuca sp.*), sheoak (*Casuarina Fraseriana*), *Adenanthos obovata*, Southern Cross (*Xanthosia rotundifolia*), blackboys (*Xanthorrhoea Preissii*), and some kangaroo "grass" (*Evandra aristata*), teatree (*Agonis parviceps*) and bottlebrush (*Beaufortia sp.*).

Type D sand (Ds).

This type is a strongly podsolised sand related to the Kwilalup sand, but instead of a fairly hard coffee rock, it shows usually a B horizon of coffee coloured sand not cemented or only weakly cemented. This layer commences at 18 to 36 inches from the surface and is up to 12 inches thick, then passing into yellow, or yellow grey or grey sand. Clay seldom occurs within 42 inches. The A horizons consist of dark grey or grey black sand with organic matter, becoming light grey to white at about 12 inches. Rounded quartz gravel has been found in some profiles and ironstone gravel may occur below 36 inches.

Type D appears to have developed on old colluvial and alluvial deposits of deep sand and seems closely related to type C in this respect. Areas of types C and D often occur together in fact. It has been noted that areas of type D are often sufficiently moist in summer from seepage to promote a good growth of Paspalum. Round rushes occur in scattered clumps on cleared areas.

The type appears to have supported a jarrah-marri vegetation association of better grown trees than on the Kwilalup sand.

Plantagenet peaty sand (Pps).

This type, which embraces the soils of the wet heaths—open kangaroo "grass," bottlebrush, blackboy "flats"—in the country west of Denmark is fully described by Hosking and Burvill (1938). It has formed on sandy deposits 6 feet and more in depth, which must have accumulated in the course of geological erosion to form the present topography. Restricted drainage causes these areas to be very wet in winter, and even in mid-summer the upper layers are usually moist and free water sometimes occurs within 3 feet of the surface.

On the Research Station two main areas occur adjoining the eastern boundary. The surface of grey black or dark grey sand is matted with roots and decomposed organic matter so that a layer of one to three inches is often rather peaty. The

organic matter decreases with depth and the sand is light grey to white below 12 inches. Dark brown streaks sometimes appear below 2 feet, and below 3 feet a soft brownish black cement or soft coffee rock occurs in some profiles, while in other cases the light grey sand with some dark brown staining continues to 6 feet. Quartz grit and gravel occur in the profiles of some areas but ironstone gravel is not found.

While the natural vegetation is usually scrubby, stunted jarrah occurs scattered in some parts, and quite large blackbutt (*Eucalyptus patens,* up to 30 feet) grows on other areas. The principal members of the vegetation noted on the Research Station were kangaroo "grass," bottlebrush, teatree, blackboy, paper bark, various rushes, green kangaroo paw (*Anigozanthos flavida*) and moss, with stunted jarrah and blackbutt.

Willbay sand ($W^{b}s$).

This is also developed on deep sandy deposits, but is better drained than the Plantagenet peaty sand and supports a timber vegetation association. The area in the north-east of the Station has been mapped as a *very gritty phase* because, to a depth of 8 feet, the sand contains much well rounded, as well as angular, quartz grit. Blackish grey sand, with organic matter and roots near the surface, passes to grey and then light grey gritty sand at about 12 inches. In a type sample boring this continued with odd brown stainings to 8 feet. The next 6 inches consisted of successive layers of grey sand and yellow gritty sandy clay loam, then a pale fawn gritty clayey sand continued for 8 inches to the maximum depth of boring, 110 inches. No free water was found, although 6½ inches of rain had fallen in the previous week.

The vegetation on this area includes sheoak, stunted jarrah, blackboy, teatree, *Pultenea reticulata*, various rushes, odd bottlebrush and prickly or holly leaved banksia (*Banksia ilicifolia*).

Group III.

This includes soils formed over basic rocks. As in the district survey, they have been found to be the least acid soils of the area with pH value about 6 (see Table 3).

Hosking and Burvill (1938) describe two soil series, the Scotsdale and the Koorundurup, developed on basic rocks. Of these, the latter is represented on the Research Station by the Koorundurup gravelly loam ($K^{r}gl$) but no typical Scotsdale profiles were found, and a new type, E gravelly loam (Egl), has been mapped to include soils showing some features of the Scotsdale soils.

Koorundurup gravelly loam ($K^{r}gl$).

This occurs in the bull paddock (No. 8) and south of the river in paddock No. 11. It has a chocolate to dark grey sandy loam to clay loam surface, sometimes gravelly, which passes below 6 inches into dark grey and dull yellow mottled very plastic clay. Sometimes brown and red colours occur with depth in the mottled clay and greenish decomposing basic rock may occur below 2 feet. Areas of this type are relatively flat and basic rock outcrops (? diorite) are associated with them.

Type E gravelly loam (Egl).

This occurs principally in paddocks 11 and 11A up the slope from the Koorundurup gravelly loam. Basic rock outcrops are again a characteristic feature. The soil profiles show the following features:—

(a) A few inches of dark brown loam which may be gravelly and which is darkened by organic matter.

(b) Brown to red brown loam or clay loam changing to brown clay at about 12 inches. Some fine soft gravel as in the Scotsdale soils sometimes occurs.

(c) Yellow and grey mottled plastic clay at about 18 inches. Sometimes brown and red brown colours also are noted.

(d) Decomposing basic rock with green, yellow and brown colours, representing the C horizon, was found at 42 inches in a type sample boring.

Ungrouped Soils.

Type F sandy loam (Fsl).

This is the main soil type occurring on the oldest parts of the Research Station between the Scotsdale road and the river, but does not occur in that part of the district covered by the soil survey reported in C.S.I.R. Bulletin No. 115. It was probably timbered originally with karri, and appears to be formed on old alluvial deposits. The surface colour and texture are not uniform throughout the area, but there are no well marked boundaries and the subsoil features are fairly consistent so that no subdivision has been attempted.

The surface soil, which is darkened by organic matter and has no doubt been ploughed in these old paddocks, is grey, grey brown or dull brown loamy sand, sandy loam or loam, sometimes with slight gravel. This passes at about 9 inches into yellowish grey or grey brown sandy clay loam or sandy loam. Clay increases with depth and a dull yellow sandy clay is found at 15 to 18 inches. Below 20 inches the sandy clay or clay becomes mottled grey, yellow and red or brown. In a type sample boring the clay became gravelly and more sandy at 48 inches. The ferruginous gravel and also quartz grit continued to 6 feet, the depth of boring.

Some areas with browner and more gravelly surfaces than usual occur in the north part of the bull paddock (No. 8) and are included with type F sandy loam.

Alluvial Areas (Mapped A).

Alluvial deposits of relatively recent origin occur along the banks of the river in places, and the creek flowing from the east through paddocks 17 and 13 has developed a moist alluvial flat near its junction with the river. According to old records, this area was originolly a dense paper bark swamp, and the creek course has been straightened and deepened since clearing to improve drainage. All the alluvial areas mapped are liable to, or just out of reach of, winter flooding.

The profiles of these areas usually show variations in texture due to layering of deposits. On the main area in paddocks 13, 11A and 12 the surface varies from grey fine sandy loam to a grey black organic loam. At 3 to 12 inches depth a dark grey or black clay occurs. This may become more yellow with depth and generally becomes more sandy. Below 2 feet layers of light grey or grey and yellow clayey sand or sand are found, and further sandy clay lies below 3 feet. Other alluvial areas have mostly grey sand or sandy loam surfaces, with grey or black clay at about 9 to 18 inches. Layers of sands and sandy clays, mottled grey and yellow, occur to the usual depth of examination (42 inches).

Rusty mottlings are common in the surface soils indicating periodical waterlogging.

Undifferentiated Wet Soils (U and swamp symbols).

Areas where springs occur on slopes or where seepage keeps the soils permanently moist are not included with other soil types, but are grouped as undifferentiated wet soils. Such areas may be very useful for summer pastures.

River Sandbanks.

In the main bend of the river east of the farm buildings occur sandbanks apparently deposited from the river floodwaters near the junction with the creek which enters from the east at this point. The sand on these banks is grey at the surface due to organic matter and yellow to orange below about 6 inches.

Rock Outcrops.

A few areas consist mostly of outcropping rock—some acidic and gneissic and some basic—with practically no soil, and are mapped as rock outcrops.

LABORATORY EXAMINATION OF TYPE SAMPLES.

Hosking and Burvill (1938) have reported a comprehensive range of chemical data on the soils of the Denmark district, and in the present work the laboratory examination has, therefore, been restricted to the determination of gravel and stone in the field samples, of reaction (pH), and of conductivity and chloride for a number of subsoils.

Gravel and Stone.

As their names imply, several of the soil types contain considerable amounts of gravel (greater than 2 mms). The amounts determined in the type samples are shown in Table 2, from which it is seen that the surface and subsurface layers of types like the Wakundup very gravelly sand and the Koorrabup very gravelly sand range from 52 to 81 per cent. gravel. The Koorrabup gravelly sand on the Research Station is not gravelly in its surface layers, but big laterite stone and gravel has been found at the bottom of the A_2 horizon—the type sample contained 48 per cent.

The soils of Group II. are generally not gravelly in the surface and subsurface layers. The Kordabup sand (no type sample) is an exception and may contain ironstone and/or quartz gravel. Rounded quartz gravel was also found in some profiles of Kwilalup sand and type D sand.

The "coffee rock" hardpan of the Kwilalup sand, contained 44 per cent. of gravel when sieved after gentle grinding. The gravel contained several rounded quartz pebbles but was made up principally of dull yellow, rather soft ferruginous gravel of irregular shape. Some of the larger pieces showed on breaking a dark brown hard centre suggesting that the gravel may be undergoing hydration and softening from the outside.

The deep subsoil of type D sand contained 9.7 per cent. gravel. This was ironstone gravel of very irregular shape and contained a large proportion of quartz sand cemented by the iron oxides. It may be forming at present with seasonal fluctuations in water table causing alternations of oxidising and reducing conditions. The Willbay sand occurs on the Research Station as a very gritty phase and hence has much higher gravel percentages (up to 21 per cent.) than occur in the normal phase. The grit is mostly less than 5 mms. in size and consists principally of quartz including many well rounded pieces. Several larger rounded quartz pebbles occurred in the deep subsoil.

The soils of Group III., formed over basic rocks, contained variable amounts of gravel apart from odd stone floaters in the profiles. Small, hard, dark brown ferruginous gravel is characteristic of the surface and subsurface, while some angular quartz fragments and very small pieces of decomposing rock also occurred in the subsurface sample of type E gravelly loam. Small, soft, reddish brown gravel as described by Hosking and Burvill (1938) for the Scotsdale series was also noted in some of the profiles of this type

TABLE 2.

GRAVEL AND STONE (GREATER THAN 2MMS.) IN TYPE SAMPLES—DENMARK RESEARCH STATION, EXPRESSED AS PER CENT. OF FIELD SAMPLE.

Horizon.	Group 1.				Group II.				Group III.		Ungrouped.	
	Wvgs	Bls	K^{o}vgs	K^{o}gs	K^{w}s	Ds	Pps	W^{b}s	K^{r}gl	Egl	Fsl	A
	%	%	%	%	%	%	%	%	%	%	%	%
Surface (A_1)	52·4	1·8	57·4	*Nil*	Trace	*Nil*	*Nil*	8·6	1·2	*Nil*	3·3	*Nil*
Subsurface (A_2)	81·2	†4·0 / 26·3	62·9	†*Nil* / 48·0	Trace	*Nil*	Trace	20·9	2·0	‡8·7	*Nil*	*Nil*
Subsoil (B)	*32·6	0·1	13·4	51·0	44·1	Slight	Trace	15·7	Odd big stones	*Nil*	*Nil*	Trace
Deep subsoil (C)	*disc.	0·9	11·5	0·7	0·8	9·7		9·6	...	2·2	†2·2 / 23·7	Trace

* Samples contaminated from A horizons. † Gravel mostly in lower part of these horizons. ‡ Includes a stone floater which accounted for most of this weight.

TABLE 3.

REACTION* (pH) OF TYPE SAMPLES—DENMARK RESEARCH STATION.

Horizon.	Group I.				Group II.				Group III.		Ungrouped.	
	Wvgs	Bls	K^ovgs	K^ogs	K^ws	Ds	Pps	W^bs	K^rgl	Egl	Fsl	A
Surface (A_1)	5·52	5·64	5·64	5·72	4·74	4·64	4·38	4·79	6·06	5·88	5·45	4·73
Subsurface (A_2)	5·96	5·94	5·42	5·64	4·98	5·30	4·81	4·98	5·74	6·38	5·92	4·64
Subsoil (B)	5·92	4·49	5·96	5·60	5·14	5·59	4·38	5·42	6·08	6·29	5·39	4·54
Deep subsoil (C?)	4·66	3·98	5·31	5·59	5·09	5·64	...	4·48	...	6·62	4·75	4·41

* Determined on 1 : 5 extract using the quinhydrone electrode.

The sampled profile of type F sandy loam contained a notable amount of gravel in the deep subsoil. As with type D sand this was ferruginous gravel of irregular shape and contained a large amount of quartz sand. Its formation may be associated with seasonal fluctuations in the water table. The gravel of this layer also included a small proportion of quartz pieces some of which were well rounded. This supports the suggestion that this soil type appears to be formed on old alluvial deposits.

Reaction (pH).

The pH values for the type samples are shown in Table 3 from which it is seen that the most acid soils are in Group II. and the least acid in Group III. In Group I., for all profiles, the deep subsoil has the lowest pH, that for type B loamy sand falling to 3.98. On the contrary, in Group II., for all types except the Willbay sand the surface soil is more acid than the lower layers of the profile.

Water Soluble Salts.

To obtain a measure of the water soluble salts in the subsoils and deep subsoils of a number of types, conductivity determinations were carried out on the 1:5 soil : water extracts. Chlorides were determined by Best's method using the silver-silver chloride electrode. The results are given in Table 4 in which chlorides are expressed as sodium chloride, while the Specific Resistance gives a measure of the total water soluble salts—the *lower* the Specific Resistance the *higher* the concentration of salts.

TABLE 4.

SPECIFIC RESISTANCE AND SODIUM CHLORIDE DATA FOR SUB-SOILS AND DEEP SUB-SOILS DENMARK RESEARCH STATION.

Serial No.	Type.	Depth.	Specific Resistance 1 : 5 Extract. (60°F.)	Sodium Chloride (Per cent. Oven-dry Soil).
	Group I.—	ins.	ohms.	%
2678	Wakundup very gravelly sand	54—60	8,900	·027
2688	Koorabup very gravelly sand	24—36	11,600	·020
2689	do. do. do.	36—60	12,700	·017
2695	Koorrabup gravelly sand	58—69	13,100	·017
2705	Type B loamy sand	24—42	4,120	·060
2706	do. do.	42—60	2,750	·093
	Group II.—			
2720	Kwilalup sand	32—41	8,900	·025
2721	do.	41—50	6,900	·032
2701	Willbay sand	96—110	10,600	·017
	Group III.—			
2729	Koorundurup gravelly loam	18—30	7,700	·018
2725	Type E gravelly loam	13—33	6,050	·023
2726	do. do. do.	33—42	7,400	·022
	Ungrouped—			
2683	Type F sandy loam	30—48	3,940	·033
2738	Alluvial soil	32—42	1,455	·15

The figures call for little comment. They indicate that in general both total salts and chlorides occur in small quantities only. The figure of 0.15 per cent. sodium chloride in the alluvial soil profile from paddock 13 may represent a moderate accumulation by seepage during the summer from the surrounding higher land.

RELATIONSHIP OF SOIL TYPE TO PASTURE DEVELOPMENT.

It has been mentioned earlier that the soils of the Research Station fall naturally into groups on the basis of such factors as profile features, reaction, parent rock, drainage, etc. From the standpoint of pasture development the types within these groups may be expected to have certain common features, and this has in fact been the experience in the Denmark district. Most of the pasture establishment has been on the karri and jarrah hill types of Group I. and Group III., principally the former, since soils formed over basic rocks (Group III.) are not very extensive. On the other hand, the development of the more acid podsols of Group II. has not been extensively undertaken and there has been a number of disappointments where attempts have been made. These strongly podsolised types are very extensive in the south coastal areas, and their successful development would greatly improve the carrying capacity of many partly developed farms, as well as point the way to the opening up of further new areas when desirable. It is therefore fortunate that the Research Station has available for experimental purposes areas of types such as the Kordabup sand, Kwilalup sand and the Plantagenet peaty sand, the latter two being, of course, the common soils about Denmark on the open kangaroo "grass," bottlebrush flats, and the bordering stunted jarrah country.

It cannot be assumed that experience on one soil type, within Group II., say, can be applied without modification to all the types of the group. For instance in Paddock 20, the area of Kordabup sand hardpan phase, has developed quite a fair mat of subterranean and hop clovers while the Kwilalup sand on several parts of the Station has so far given very poor results with subterranean clover. Also, several areas of Type D sand, with profiles generally similar to the Kwilalup sand, carry good swards of Paspalum and subterranean clover. Yorkshire fog and drooping flowered clover seem more tolerant of the conditions unfavourable to subterranean clover, and these two were noted scattered over parts of the area of Plantagenet peaty sand in paddock 17. There is a hope that a "minor" element—copper—may prove to be a decisive factor in successful pasture establishment on the Plantagenet and Kwilalup soils.

The most successful established perennial pastures on the Station are on the types formed over basic rocks, and on type F sandy loam which is the most important soil on the oldest part of the Station. In these pastures perennial rye grass, cocksfoot and paspalum have been successfully established and the dominance of subterranean clover appears to have been overcome. The Group I. soils on the Station, including the important gravelly sands and very gravelly sands of the Wakundup and Koorrabup series, have shown their ability to grow excellent subterranean clover when fertilised with superphosphate. Their treatment and management to produce more mixed pastures including perennial grasses is an important district problem, and may reveal further individual characters of the soil types.

ACKNOWLEDGMENT.

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REFERENCE.

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GENERAL MANAGEMENT OF SHEEP.

HUGH McCALLUM,

Sheep and Wool Inspector.

In dealing with a subject as comprehensive as the sheep industry, this article must necessarily be confined to brief references to the main points of interest, any one of which could quite easily be made the subject of an article in itself.

The co-operation between the farming community and the Department of Agriculture is increasing every day, and the exchange of information has been of great benefit and will be of still greater benefit. There are many important events that happen during the year in farmers' flocks which, if properly tabulated and investigated, would solve many problems in sheep breeding. Sheep on the farm are essential to enable the farmer to obtain the highest possible returns: therefore their management plays a definite part in the farm activities.

Western Australia has become a very large producer of sheep, wool and export lambs, but for her to rank as a premier producer changes are required in the methods of sheep breeding of many owners, who do not conduct their sheep husbandry operations as business men. Obsolete methods are not for the modern age, and "better type sheep and wool" must be the slogan. The breeders of high-class sheep are doing their part; they continue to progress. Production of quality sheep and wool must go on: in this way only can we hope to exploit this great source of wealth.

Whilst the improvement in the breeding sheep is one of the main objects to be attained, the question of losses through neglect, incorrect feeding and other causes, must be studied and means adopted to successfully combat them. Over-stocking and under-feeding are outstanding faults in management; the latter, in particular, should never occur in this State where reserves of feed can be conserved. A farmer should know the carrying capacity of the farm and stock accordingly with the type of sheep most suited for his district, remembering it is not numbers that count in sheep husbandry but quality.

To the beginner on the wheat lands merino sheep are recommended and the animals selected should be of good constitution and conformation, large-framed and growing fleeces of good value commercial wool.

As production is the main objective in sheep breeding, the flocks must be watched carefully to ensure that they do not deteriorate and lose their former vigour through the introduction of inferior sheep and the wrong type of rams. There are rules in sheep breeding which must be observed and one of the most important is to avoid breeding from extremes of type, a practice which, unfortunately, has been followed by many breeders.

Sheep and wool demonstrations and lecturettes at Agricultural Shows have done much to assist the farmer gain a knowledge of good type sheep. The improvement of the flocks requires much patience and perseverance and a fixed idea in the minds of breeders of the object to be attained. Good progress has been made in the industry, but there is still much to be learned, not only by the ordinary farmer but also by the more experienced man. The farmer should endeavour to become a good judge, in order to notice the bad, as well as the good points of an animal. He must know his flock intimately to decide the type to be retained and that to be culled, and this knowledge will enable him to accurately select or describe the type of rams required. The better the husbandry of the sheep, the stronger and healthier

will be the offspring, and they, it must be ever remembered, are the future flock. Frequent changes to different pastures and the supplementing in the diet of elements that are deficient in the soils, by means of licks, etc., add to the general health of the flock.

SELECTING THE RAMS.

The important business of selecting suitable rams to mate with the ewes calls for attention. In doing this the general character of the flock must be borne in mind and also the faults and defects which must be eliminated, as far as possible, in the next generation. To this end the sires should be exceptionally strong in those points where the ewes are faulty. Good quality, pure breeding and strong constitution are essential qualities of the ram, together with as much style and finish as it is possible to obtain, for on him largely depends the quality of the future flock. The stand of the animal should be examined; some rams stand square on their feet, others are very faulty; particular care should be taken to see that there is no inclination to weakness in the hocks—straight hocks and good action are outstanding points of a well-bred ram.

Farmers should purchase their rams from one of the registered stud breeders, who, generally speaking, are men who have made a life-long study of sheep breeding, or who, at least have a far wider experience in sheep raising than the average farmer. In purchasing from these breeders a farmer—in addition to obtaining his annual supplies—is gaining the benefit of their wider experience; again, he can be relatively sure of purchasing rams of sound constitution. This quality in a sheep is of fundamental importance and is largely the product of hereditary influence which stud breeders develop in their systems of breeding. Having selected the breeder whose rams give satisfactory results, the farmer is wise to purchase annual drafts of rams from him. Adherence to this policy and careful annual culling of the flock must quickly give good results.

SELECTING THE BREEDING EWES.

Often the farmer does not realise the importance of the ewes in building up a flock to his ideal type. They must be carefully selected for their requisite qualities. Leading characteristics which ewes should possess are constitution, conformation, trueness to type, vitality and fertility. With strong vitality the ewes can stand reverses, but they should be cared for, especially during gestation and at lambing time. Fertility is essential; no ewe that has failed to produce lambs should be kept on the farm. There are too many unproductive ewes retained year after year, for reasons difficult to understand. Good lines of "cast for age" ewes can be purchased from breeders off shears. Each season, after shearing, the older ewes are sold, the younger ones taking their place. Having been retained by the breeder for several years these sheep are generally a very even line and can be recommended.

Provided they receive fair treatment and good pastures, these ewes, when mated to rams of quality, will produce high grade lambs. Most of the good flocks pastured in the wheat belt were bred from sound-mouthed "cast for age" ewes. Even though they are cheap, broken-mouthed sheep should never be purchased.

It is not wise for the farmer to bargain unduly over the price asked by the vendor of good sheep. The time, cost and work involved in breeding up a uniform flock must be borne in mind and by starting on sound lines many years of unprofitable work in selecting, mating, breeding and culling are saved. Success or failure will depend entirely on the farmer's own ability.

The rams and the ewes should be in good condition before mating; ewes that are poor throughout the year cannot produce good lambs and the lambing percentages are always low. The lambs lack stamina and never develop into sheep which compare with those from flocks fed evenly throughout the year.

CLASSING THE FLOCK.

Before shearing each year the flock should be classed to permit of the rejection of all undesirable animals that do not come up to standard. The average farmer can with a little judgment cull many unprofitable sheep from the flock. The percentage of rejects will greatly depend on the standard of excellence set as the flock type. The retention of inferior sheep will retard the improvement of the flock and cause a marked deterioration in the quality of the wool produced. The returns of many farmers who do not class their sheep, in consequence, are much lower than those from flocks where culling is practised.

IMPORTANCE OF CORRECT MATING.

Many flocks have been ruined by introducing fresh blood strains or types quite unsuitable in general characteristics. Graded ewes are essential, as high-class rams cannot reasonably be expected to give the best results when mated to inferior dams. It is not possible to eliminate all defects at the one time, because any given characteristic cannot be fixed in one generation. Flock improvement by careful selection and mating is dependent upon prepotency, the value of which can be determined by the contrast of the improved and unimproved flocks. The prepotency of individual sheep can be judged only from a knowledge of their progeny. Since every sheep owner is not gifted with the knowledge of what to mate and what not to mate, this is a very great problem, but it is hoped these remarks may help to some extent. To mate extremes means disaster; if a medium between two extremes is desired it can only be achieved by working up gradually from one and down from the other. There is no short way in sheep breeding; the work requires patience and constant study.

LAMBING SEASON.

The number of lambs raised largely depends upon the care given by the breeder to the flock during the lambing period. The ewes require constant daily attention and new born lambs not strong enough to help themselves must be cared for. Undulating country is the best for lambing, as it enables the ewes and lambs to escape exposure to cold winds; the provision of shade and extra shelter are also of benefit. The increased number of lambs reared and the value of the ewes saved will repay the extra care during the lambing season.

LAMB MARKING.

The safest time for lamb marking is in dry, cool weather and when the animals are 4 to 6 weeks old. Cleanliness is essential and all knives and instruments must be sterilised and kept in a sterile condition by dipping in a good antiseptic whilst in use. All refuse must be cleaned from around yards and as far as possible the dust kept down. The animals must be firmly but carefully handled and should not be driven too fast either before or after the operation, otherwise heavy losses from bleeding may occur. The operations are performed in the order—earmarking, castration and tail docking. When the marking is completed the sheep should be held close at hand until all the lambs have been mothered, otherwise there is often a loss of motherless lambs.

WEANING THE LAMBS.

The lambs should be permitted to run with the mothers as long as possible. A paddock should be reserved for the weaners and the pasture should contain a variety of feed.

It is necessary that young sheep should continue to develop as they never completely recover if they once receive a severe setback. When separated from the mothers the lambs must not be left entirely alone; a few dry ewes run with them will help steady down the weaners.

COMBATING THE BLOW-FLY

The blow-fly pest, which annually involves breeders in heavy losses, has long since become a source of serious trouble to the sheep industry. Some years the mortality is much greater than others, due largely to more favourable weather conditions for the breeding of the flies. Breeders should watch the flock for affected sheep and apply suitable dressings immediately. Fly strikes, however, will be greatly prevented by the use of a good repellant after crutching.

CRUTCHING THE SHEEP.

One of the most efficient methods of combating the blow-fly is good crutching. The discolouration about the hindquarters of the animal is due to accumulation of dirt in the wool. This must be removed as it acts as an ideal breeding ground for the blow-fly. The work must be done as often as is necessary, but a systematic mass crutching should be aimed at instead of dealing with an odd sheep or two in the paddock, as is often the case.

The actual operation should be started by clearing the wool from behind the udder and between the hind legs. This section is done with the sheep sitting on its haunches, with its back leaning against the closed legs of the shearer. The animal is then laid slightly on one side and the wool removed from the back of the lower leg and just beneath the tail, then turned over and the opposite hind leg is treated likewise. It is advisable for a narrow strip of wool to be taken off from just above the tail. Great care must be taken when crutching pregnant ewes; there is no necessity for the shearer to lean on the sheep with the knee or press heavily on the flank with the fist. The rough handling of ewes results in premature births, malformed and dead lambs.

TICK AND LICE.

This is a matter of vital importance to the sheep industry. The farmer must be constantly on the alert to see that the flock is free from infestation. These blood-sucking parasites do much damage to the sheep and their wool. It is essential, therefore, to dip the flock. The ideal time to dip is from four to six weeks after shearing. Most of the standard commercial dips are suitable, and it must be borne in mind that for satisfactory results the instructions supplied by the makers must be strictly adhered to. Unless the sheep farmer makes a determined effort to eradicate these pests they will sooner or later reduce his sheep and wool to a very unprofitable state.

FOOT ROT.

The highly contagious character of foot rot is a proven fact and therefore any good system of treating an outbreak in a flock must include immediate isolation of the affected sheep. If this system is adopted early there will be every chance of

controlling the disease and curing the animals already affected. If the disease gets out of control, isolation is useless and foot-bath treatment will have to be replaced by hand treatment.

MAINTENANCE.

Every effort should be made in some way each year to improve production, otherwise flock deterioration will set in, and if neglected will increase every year. Farmers cannot expect to take everything from the land without returning a portion of the elements taken out in some form or other, and must therefore pay attention to the husbandry of his pastures. In addition to a utility shed for shearing each farm should have good yards with a drafting race. This will save considerable time and money, repaying the initial cost of the yards in a very few years.

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ELEPHANT GRASS OR NAPIER'S FODDER.*

(*Pennisetum purpureum*—*Schum.*)

H G. ELLIOTT,

Agrostologist.

Introduction.

Elephant grass, as far as can be ascertained, was first introduced into Western Australia in 1916 by Mr. A. Crawford, then Chief Inspector of Rabbits, Department of Agriculture, who obtained a small sample of seed from Rhodesia, Central Africa. The seed was planted in his garden at Claremont and only one germinated. From the resulting plant supplies have been distributed over Western Australia.

Several cuttings were grown by the late Mr. Catton Grasby in 1917 and some idea of the rapidity with which the plant multiplies can be gained from the fact that he distributed over 4,000 cuttings in the spring of 1918 to farmers in various districts of the State.

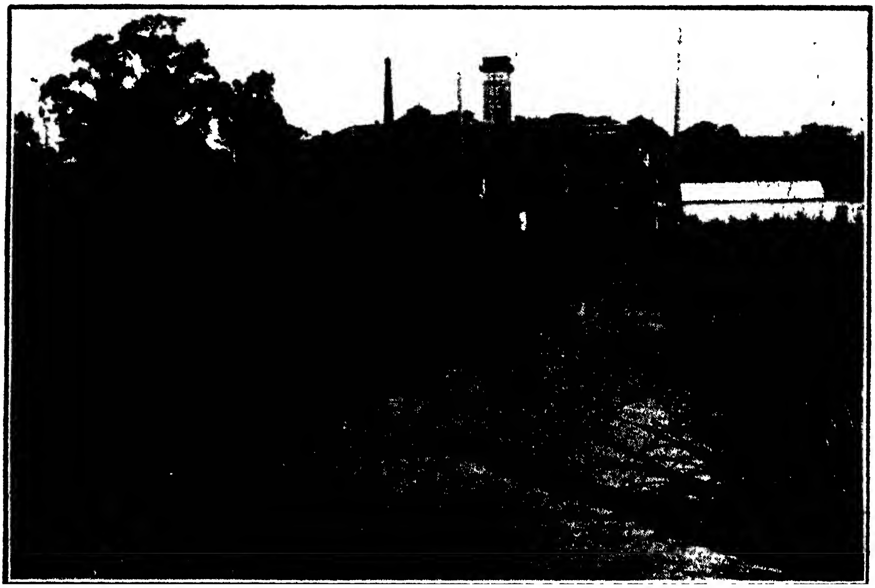
In the "Agricultural Gazette" of New South Wales for October, 1916, there are some notes on trials of this grass made in the Sydney Botanical Gardens and elsewhere in that State. Mr. E. Breakwell, B.A., Agrostologist, stated that under Sydney conditions, the trial showed that the grass is hardy and palatable, and made good growth in the winter months. Up to the time of writing, seed had not developed, but no difficulty had been found in growing the grass from rooted slips or cuttings. In Rhodesia it has the reputation of being "drought resistant capable of enduring winter conditions and adapted to light soils," and this has been confirmed in New South Wales, but the results were at the time of the report inconclusive.

Description of Plant.

A tall perennial grass with creeping rhizome, culms erect, in tufts of up to 20, six to ten or more feet in height, branched, terete glabrous, smooth excepting the uppermost internode, which is more or less hairy to tomentose in the upper

* Revised from an article of the same name by Messrs. G. K. Baron-Hay and C. A. Gardiner.—Leaflet No. 248.

part. Nodes mostly exserted from the sheaths, all glabrous, or some of them with a ring of stiff long adpressed hairs. Leaf sheaths terete, clasping the stem, striate; ligule a narrow rim bearing a dense fringe of white hairs; blades linear, very long, tapering upwards 1 to 3 feet long, with a strong midrib. Flowers in a dense cylindrical spike from 4 to 12 inches long, usually yellow or tinged with brown, purple or black-purple, composed of deciduous spikelets or bundles of spikelets, each spikelet or bundle surrounded by an involucre of numerous bristles minutely scabrid and slightly plumose towards the base, unequal, 1.2-2 or up to 4 cms. long. Spikelets sessile, or if in bundles of two to four, the lateral pedicelled or lanceolate, more or less acuminate, 5-7 mm. long, glabrous, green or straw-coloured, or tinged with brown or purple towards the tips of the florets, rarely dark purple throughout, hermaphrodite or, if fascicled the lateral male, rarely all neuter or all male. Lower glume rudimentary or suppressed, upper ovate to ovate-lanceolate, acute 0.5-1 mm. long, subhyaline 1-nerved or nerveless. Lower floret male, or more often barren; the glume lanceolate, acute or acuminate, usually as long as the upper floret, more or less distinctly 3-nerved, rarely 1 or 5 or even 7-nerved; palea linear-lanceolate, 2-nerved, shorter than the glume. Upper floret hermaphrodite, or in the lateral spikelets male, flowering



Elephant Grass at Claremont Hospital for the Insane. One month's growth after cutting, 1928.

Photo. G. K. Baron-Hay.

glume lanceolate, acuminate, minutely roughened upwards, usually 5-nerved at least in the upper part; palea narrow linear-lanceolate, slightly shorter than the flowering glume, apex minutely 2-toothed. Lodicules 0. Anthers 2.5-3 mm. long, tips very minutely penicillate. Styles united all along; stigmas very slender, up to 4 mm. long, exserted from the tip of the floret. Grain obovoid-rhomboidal, yellow, smooth and shining, abruptly tapering into the style.

The species is a native of tropical Africa, where it has a very wide range between 10 degrees N. Lat. and 20 degrees S. Lat. The northern limit runs from

Sierra Leone through the great equatorial forest zone to the Cameroons, thence to the Nile, Lake Victoria and British East Africa. The southern limits run through Angola to Katanga, thence across the middle Zambesi to Eastern Rhodesia as far east as Beira. Within this immense area it occurs principally along watercourses and in marshy depressions but occurs also in the well-lighted forest areas. It often forms reed jungles. In the drier savannahs of East Africa it is rarely more than six feet high.

In Western Australia, under drier conditions than in its native habitat, six to eight feet is considered a good growth.

The grass has been under notice in Africa since 1905, and is considered one of the best fodder grasses there, where it has been tested under severe conditions for some years.

Elephant grass was probably introduced into Australia in 1914 by the Department of Agriculture, New South Wales, which obtained a parcel of seed in that year. Only one seed germinated, the resulting plant becoming the origin of the grass in that State.

Fine variety grown by F. Coyle, Peel Estate, on light sandy soil. Note flowering heads at height of 4 to 6 feet.

Photo. G. K. Baron-Hay.

Habits.

Elephant grass (*Pennisetum purpureum*) is a coarse grass when mature, and is characterised by extremely rapid growth under moist and warm conditions. It grows in clumps which stool prolifically, and is thus usually planted in rows from four to six feet between the plants.

Mature leaves, which attain a length of 2-2½ feet are coarse, but, when the plant is grazed or cut, the young shoots, until the plant reaches a height of three feet, are soft, succulent and relished by stock.

There appears to have been several distinct strains evolved, differing in such characters as hairiness of leaf and stem, height at maturity, etc.

Up to about 1930 the common variety grown in this State had large broad leaves and flowers at from seven to eight feet. At the present time a much finer leaved variety is grown, which matures at a height of six feet. This variety grows more rapidly in the summer months.

Climatic Conditions.

Elephant grass is extremely drought resistant, but, being a heat loving plant, thrives best during the summer months. Those districts, therefore, where no summer rains occur, or where moist ground is not available, are not likely to suit it.

The grass prefers a deep, well drained loamy soil, with plenty of moisture, but has shown itself capable of growing on a variety of poorer sandy soils, under dry conditions.

Where irrigation is possible, excellent results have been obtained on the deep coastal sands as at the Claremont Hospital for Insane (see block 1).

This plant also has demonstrated its ability of growing on the jarrah and she-oak hills found in the extreme South-West, typically from Narrikup to Denmark, including Albany. These hills are of a sandy nature, either lying on solid coffee rock (a form of laterite) or studded with "floating" masses of this rock, on which soils very disappointing results have been obtained with the more common and better class pasture grasses and clovers.

Good results have been reported on the lighter soils surrounding swamps on the Peel Estate and at Bulisbrook, which retain some moisture during the summer months.

Elephant Grass on sandy loam at Redmond, near Albany, grown by Mr. J. H. McGoff.

Photo. G. K. Baron-Hay.

It was stated earlier that this grass would not be very suitable for the Wheat Belt areas—but it is now evident that it is not only useful for the Coastal districts, but also for inland areas, having been grown successfully as far inland

as Southern Cross under irrigated conditions. In many areas of our Wheat Belt it is being grown in small patches which retain moisture or can be watered in the summer time.

Cultivation and Method of Planting.

As seed is difficult to procure, propagation is carried out from roots or cuttings.

Roots or young rooted plants are preferable to cuttings, as growth is more rapid, failure to strike very rare, and a cut can be obtained 10-12 weeks after being first planted, if sufficient moisture is available.

A single plant will produce as many as 40-50 young rooted stems in one season.

Rooted plants may be planted at any time of the year, if the soil is moist, but cuttings should only be planted in the spring.

Cuttings should be taken from the hard portions of the stem, and have three joints. Those taken from the softer upper portions of the stem often rot in the soil.

Rooted plants or cuttings should be planted on ground which has been ploughed to a depth of five to seven inches and well cultivated.

Where large areas are to be planted, the cuttings may be dropped in shallow furrows, three inches deep, and the earth ploughed back on to them. Small areas may be "dibbled" in, leaving one node (joint) exposed.

Fertilizer.

Superphosphate at the rate of 2 cwts. per acre should be applied at planting and a subsequent topdressing with at least 1½ to 2 cwts. of superphosphate per acre each spring.

Stable, cow, poultry or any farmyard manure can be applied more or less *ad lib.* with beneficial results.

It has been found that good intercultivation in the autumn and spring is beneficial.

Seed.

Elephant grass has not been known to form viable seed in the temperate portions of the State, *i.e.*, south of Geraldton, though in its native habitat seed is commonly produced.

Seed obtained by Mr. P. G. Hampshire, however, and grown by Hon. E. H. Angelo, M.L.C., Leura Farm, Carnarvon, in 1923, gave a good percentage of germination, namely 47 per cent. which compares favourably with the percentage of germination found in good quality samples of Rhodes grass seed (40 per cent.). It would seem possible, therefore, that should seed be required supplies can be drawn from the North-West of this State.

Value as a Fodder Plant.

Where ample moisture is present, Elephant grass has a remarkable rapidity of growth and stooling characteristics and can be cut four to six times in one season and will produce up to 50 tons of green fodder per acre. It is highly palatable, but becomes coarse if allowed to grow too high. It should be cut when

three to four feet high. Analyses show that the value of this grass is high, figures for Sudan grass and Maize are given for comparison:—

——	Water.	Crude Protein.	Fat.	Carbo-hydrates.	Indig. Fibre.	Ash.
Elephant Grass (N.S.W.)	63.82	3.25	0.41	15.71	14.01	2.80
Sudan Grass	63.9	2.0	1.1	21.5	8.4	3.1
Maize, Green	76.9	1.9	0.6	13.9	5.5	1.2

Over the last few years much attention has been paid to this valuable fodder plant, by dairy farmers and poultry raisers.

THE SOWING OF PASTURE SEEDS.

G. K. Baron-Hay, Superintendent of Dairying, and H. G. Elliott, Agrostologist.

During recent years a considerable and growing interest has been exhibited by farmers in the possibilities of improving the quality of pasture on various types of soil. This has led to numerous inquiries being received by the Department, particularly requesting information regarding the types of soil suitable for the growing of different strains of pasture plants and the rates of seeding recommended for these varieties. It, therefore, is hoped that the following notes setting out briefly the preparation of the soil required for the sowing of pasture seeds, and also the types of plants recommended for varying districts, will serve as a guide to those farmers desiring to improve or resow portions of their land to pasture

Preparation of the Soil: Where subterranean clover alone is being sown good surface scarifying of the soil is required. With the other pasture species, however, independent of the type of soil to be planted, it is essential, in order to secure good germination, that the surface soil be of a fine tilth and that beneath this surface layer, which should be shallow, say, three-quarters of an inch, the seed bed should be well consolidated.

Where mixtures containing perennial grasses are included, it is requisite that the soil should be fertile, and it therefore is undesirable, as a rule, to sow these types of pasture plants on virgin soil.

For pastures containing perennial species the land to be planted should be fallowed in spring, cultivation being carried out during the summer months to consolidate the seed bed and also to destroy germinated weeds. Where the soil is poorly drained, ploughing should be carried out in narrow lands.

The growing of a crop of potatoes or maize during the previous summer may obviate the leaving of the land fallow, and has the effect also of enriching the soil, as these crops usually receive a heavy dressing of fertiliser containing nitrogen, phosphate and potash. Some form of summer cultivation such as that indicated above is necessary, so that the seeds may be planted and germinate early in autumn while the soil is still warm, without fear of competition from weed seeds.

Irrigated land may be freed from weeds by watering, which will germinate these, and a cultivation to destroy the weeds after their germination.

Fertilisers: Phosphatic fertilisers are essential and, on fertile ground containing a good supply of humus or organic manure, 2 cwts. of superphosphate are recommended. Where the pasture mixture contains permanent grasses, however, and there is some doubt as to the fertility of the soil, a fertiliser containing superphosphate five parts to one part nitrogen is recommended, such as superphosphate and ammonia No. 2 at the rate of 2 cwts. per acre.

Depth of Seeding: Pasture seeds should not be sown at a greater depth than three-quarters of an inch, or less than quarter of an inch. If the land is moist to the surface, broadcasting may be practised, followed by a light rolling. A guide in depth of sowing is that "seeds should not be sown deeper than a distance equal to four times their diameter."

Method of Seeding: Drilling is preferred, and has the advantage of giving a better and more even germination. The seed may be mixed with the fertiliser, but mixing should not take place until it is desired to sow, or the seed may be sown through the small seeds attachment which can be attached to a "drill" or "combine."

Should the seed bed be firm, broadcasting the seed and fertiliser, followed by a light brush harrowing, would give good results.

Time of Seeding: Autumn planting is the general rule. Spring planting is only recommended where sufficient moisture is present to insure germination, or irrigation water is available.

Quality of Seed: A great deal of attention has been paid in recent years to the differences found between strains of the same species of pasture plants. Where possible, seeds should be purchased carrying a certificate from some reputable authority, preferably a Government institution, setting out the strain, percentage of germination, freedom from disease and weed seeds. Seed certification aims at providing the producer, the merchant and the purchaser, with some independent and authoritative assurance that the seed certified has certain claims to recognition from the viewpoint of strain and performance. Should the seed purchased be of a low germinating capacity or a non-persistent strain, the total outlay of preparation may be wasted, or, worse still, a direct injury ensue from the harmful nature of weeds introduced.

Rate of Seeding: The rate of application of pasture seeds per acre varies considerably from district to district, owing to the large area of the State deemed suitable for the growth of some species of pasture plants. The amount of seed to be sown when endeavouring to establish pasture depends on several factors, as follows:—

1. Type of soil.
2. The variety and quality of seed.
3. The condition of the seed bed.
4. The seed mixture to be sown.
5. The climatic conditions governing the district in question.

In all instances, however, the aim in pasture production is to cover the surface of the land with an even sward of fodder as quickly as possible.

The following tables setting out the rates of seeding recommended have been prepared to suit average conditions, where farmers have already certain species present in their pastures they can alter the given mixtures recommended. Each mixture has been carefully compiled from experimental data obtained giving due regard to the soil and climatic conditions.

"A." Where pure stands of any particular variety are to be sown without a cover crop.

"B." For the sowing of pure stands of a particular variety with a cover crop.

"C." The sowing of pasture mixtures under various conditions.

"A."—*Pure Stands Without Cover Crop.*—Table 1 sets out the rate of seeding recommended for single plant pastures in the three main districts of the State identified by rainfall:—

TABLE 1.

RATE OF SEEDING FOR SINGLE PLANT PASTURE.

Seed.	South and South-West Rainfall of 28in. to 60in.	Areas with Rainfall of 18in. to 28in.	Areas with Rainfall of 18in. and less.
	lbs. per acre.	lbs. per acre.	lbs. per acre.
Wimmera Ryegrass	8 to 10	4 to 6	4 to 6
Italian Ryegrass	8 " 15	6 " 8	(*b*)
Perennial Ryegrass	6 " 10	6	(*b*)
Cocksfoot	6 " 10	(*a*)	(*b*)
Phalaris tuberosa	2 " 3	2	1 to 2
Veldt Grass	2 " 4	2 " 4	2
Yorkshire Fog	2 " 6	(*a*)	(*b*)
Timothy	4 " 6	(*a*)	(*b*)
Tall Fescue	6 " 10	4 " 6	(*b*)
Subterranean Clover	4 " 8	2 " 4	4 to 6
Drooping Flowered Clover (Scarified)	2 " 4	2 " 4	(*b*)
White Clover	2 " 4	(*a*)	(*b*)
Cluster Clover	4 " 6	4 " 6	3 to 4
Suckling Clover	4 " 6	4 " 6	3 " 4
Red Clover	6 " 8	(*a*)	(*b*)
Lucerne	8 " 12	4 to 8	3
Burr Medic	6 " 10	6	4
Barrel Clover	4	3 " 4	2 to 4
Lotus major	2 " 4	(*a*)	(*b*)
Lupins	½ to 1 bush	½ to 1 bush.	(*a*)

(*a*) Only recommended on favourable light or moist land.

(*b*) Not recommended to plant.

"B"—*Pure Stand With a Cover Crop.*—In many districts the practice of establishing pasture in two years by the use of a cover crop is quite common. The advantage of this method is that less seed per acre of the pasture plants is required, as these plants will thicken during the second year by seeding, only annual pasture plants being generally used.

Table 2 gives the rate of seeding where such pure stands are required following a cover crop, usually a cereal:—

TABLE 2.

SEEDS SOWN WITH A COVER CROP.

Seed.	South and South-West Rainfall, 28in. to 60in.	Rainfall of 18in. to 28in.	Rainfall of 18in. and less.
	per acre.	per acre.	per acre.
Wimmera Ryegrass	4 lbs.	2-3 lb.	½–1½ lb.
and Oats	1½–2 bush.	1 bush.	1 bush.
or Wheat	1–1½ „	45–60 lbs.	45 lbs.
Subterranean Clover	2-4 lbs.	1–2 lbs.	2-4 lbs.
and Oats	1-2 bush.	½–1 bush.	½ bush.
Crimson Clover	4–6 lbs.	3–4 lbs.	...
and Barley	1–1½ bush.	1 bush.	...
Wimmera Ryegrass	2-3 lbs.	2 lbs.	...
Subterranean Clover	2-3 „	2 „	...
and Oats	1 bush.	1 bush.	...
Lupins	...	2-6 lbs.	2–6 lbs.
and Wheat	...	45–60 lbs.	45 „

"C."—*Pasture Mixtures.*—These are usually sown in the heavier rainfall districts of the State, and any mixture should contain tall, strong-growing high-fertility grasses with a proportion (approximately 40 per cent.) of legumes. The particular mixture decided upon is governed mainly by the type of soil available and the prevailing climatic conditions.

To assist in deciding upon the mixture to be sown, Table 3 sets out the various types of soil commonly met with in the south-west portion of the State on which it is desired to establish permanent pasture.

TABLE 3.

SOIL TYPES FOR THE SOWING OF PASTURES IN THE SOUTH-WEST.

A.—Well-drained undulating country omitting gravel hills, *i.e.*—

1. With over 40 inches rainfall, *i.e.*, Denmark, Manjimup, Margaret River;
2. With 30-40 inches rainfall, *i.e.*, Donnybrook, Bridgetown.

B.—Coastal plain type: Clay loam to a heavy clay carrying red gum, flooded gum, generally requires draining, *i.e.*, Benger, Cookernup, etc.

C.—Summer moist land, excluding drained peaty swamp, including certain portions of Napier Creek country.

D.—Drained peaty swamps.

E.—Sandy to sandy loam waterlogged in winter, often carrying peppermint, stunted jarrah, etc., *i.e.*, low country around Busselton.

F.—Same as "E," but with clay subsoil, *i.e.*, 4-8 inches.

G.—Dry, more or less gravelly ridges.

Mixtures Recommended.—The various mixtures recommended under different conditions, and for the various types of soil indicated in Table 3 above, are concisely grouped in Table 4 according to whether the land to be sown is—

(a) Virgin land;.
(b) Old cultivated non-irrigable land ("dry").
(c) Irrigated land.

In sowing these pasture mixtures, particular attention should be paid to the fertility of the soil and reference made to a paragraph on "fertilisers" earlier in this article.

TABLE 4.

SEED MIXTURES FOR VARIOUS SOIL TYPES—POUNDS PER ACRE

VIRGIN LAND—AUTUMN SOWING.

A1.—Italian Ryegrass, 4-6 lbs.
Subterranean Clover, 2-4 lbs.
White Clover (certified), 1 lb.

*A2.—Italian Ryegrass, 4-6 lbs.
Subterranean Clover, 2-4 lbs.

B.— Italian or Wimmera Ryegrass, 4-6 lbs.
Subterranean Clover, 2-4 lbs.
Drooping Flowered Clover (scarified seed), 1 lb.

*B.— Italian or Wimmera Ryegrass, 4 lbs.
Subterranean Clover, 4 lbs.

C.— Spring or early autumn seeding:
Paspalum dilatatum, 10 lbs.
White Clover (certified), 1 lb.
Lotus major, 1 lb.

D.—Perennial Ryegrass (cert.), 4 lbs.
Cocksfoot (certified), 2 lbs.
Lotus major, 3 lbs.

D.—Perennial Ryegrass (cert.), 4 lbs.
White Clover (certified), 2 lbs.
Lotus major, 2 lbs.

E.—Drooping Flowered Clover (scarified seed), 2 lbs.
Yorkshire Fog, 2 lbs.

F.—Subterranean Clover, 2 lbs.
Drooping Flowered Clover (scarified seed), 2 lbs.

G.—Wimmera Ryegrass, 6 lbs.
Cluster Clover, 4 lbs.

* Kikuyu planted at 3 ft. intervals.

OLD CULTIVATED LAND— AUTUMN SOWING.

A1.—Perennial Ryegrass (cert.), 4-6 lbs.
Cocksfoot (cert.), 2 lbs.
Subterranean Clover, 4 lbs.
White Clover (cert.), 1 lb.

*A1.—Perennial Ryegrass (cert.), 4 lbs.
Cocksfoot (cert.), 4 lbs.
Subterranean Clover, 4 lbs.
White Clover (cert.), or *Lotus major*, 1 lb.

A1.—*Phalaris tuberosa* (cert.), 2-3 lbs.
Subterranean Clover, 3-4 lbs.

A2.—Perennial Ryegrass (cert.), 4 lbs.
Subterranean Clover, 4 lbs.

A2.—*Phalaris tuberosa* (cert.), 2-3 lbs.
Subterranean Clover, 3-4 lbs.

* Kikuyu planted at 3 ft. intervals.

Note.—Subterranean Clover where recommended only to be added if not already present.

IRRIGATED LAND—SPRING OR EARLY AUTUMN SOWING.

NEW LAND.

Paspalum dilatatum	8 lbs.
White Clover (cert.) ..	2 lbs.
Subterranean Clover ..	2 lbs.

OLD LAND.

1.—Perennial Ryegrass (cert.), 6-8 lbs.
Cocksfoot (cert.), 2-4 lbs.
White Clover (cert.), 2 lbs.

2.—Perennial Ryegrass (cert.), 8 lbs.
White Clover (cert.), 2 lbs.

3.—Perennial Ryegrass (cert.), 6 lbs.
Paspalum dilatatum, 4 lbs.
White Clover (cert.), 2 lbs.

4.—*Phalaris tuberosa* (cert.), 3 lbs.
White Clover (cert.), 2 lbs.

THE SMALL SEEDED HORSE OR TICK BEAN.

(Vicia faba var minor.)

H. G. ELLIOTT,
Agrostologist.

Introduction.

Horse or Tick Bean varieties are numerous but one of the most outstanding ones in this State is that known as the Bell Windsor Tick Bean. The seeds of this bean were first introduced in 1935 to this State from California, by Dr. T. C. Dunne, then Research Officer in Agrostology at Muresk Agricultural College. At the Denmark Research Station the high yield and quality of this crop has been demonstrated. This, together with its high feeding value indicates that the beans can be used to advantage much more extensively in Western Australia than is the case at the present time.

In Western Australia there is need of a legume for green manuring purposes that will grow more rapidly during the cold winter months than peas or vetches. The tick bean has demonstrated its ability to grow satisfactorily during the cold wet months, but has one objection in that it requires a fairly high rate of seeding per acre, owing to the size of the seed. The Bell Windsor variety, however, has a small seed and the rate of seeding per acre is not much in excess of that of peas.

Description of Plant.

The Tick Bean plant is an annual legume belonging to the vetch group. It is erect, with one or more large unbranched coarse stems and large leaves without tendrils. The plant attains a height of 2 to 7 feet. The leaves consist of from one to three pairs of large oval leaflets and are distributed from the base to the tip of the stems. The white flowers with dark purple markings, are borne in clusters of one to five on short stalks in the axils of the leaves. From two to five pods develop from each flower cluster. The size and colour of the seeds vary with the varieties. There is usually one strong central root with numerous spreading lateral rootlets covered with nodules when the suitable nitrogen fixing bacteria is in the soil.

Uses.

The large flat seeded varieties are used extensively as a vegetable either in a green or dry state while the small seeded varieties are seldom used for this purpose. The plant may be made into hay or silage, fed green, or ploughed in as a green manure. The beans can be used as a substitute for grain in rations of pigs or cows, and can be also ground up and form a portion of the ration for poultry.

The seeds are very high in protein as may be seen from the following analysis: moisture, 12.75 per cent.; protein, 25.41 per cent.; fat, 2.01 per cent.; fibre, 11.57 per cent.; nitrogen free extract, 45.43 per cent.; ash, 2.83 per cent. This analysis is given on an undried basis.

Soil.

Tick beans normally thrive best on heavy well drained loams, but will succeed on most types of sandy to heavy loamy soils. The plants thrive best during the winter months but do not succeed during the hot weather.

Time of Planting.

Autumn and early winter are recognised as the best times for planting the seed of this excellent and useful fodder. Sowing immediately after the event of the general winter rains in May is recommended.

Method of Sowing

It is recommended that the seed be sown in drills about 30in apart, so that inter-tillage can take place during the early life of the plants to assist in controlling weeds. In the lower rainfall areas, however, it is recommended that the seed be planted on fallow. A simple method of seeding is to lightly plough in the seed every third furrow of about 9in. wide, thus making rows about 27 to 30 inches apart.

A horse or tick bean plant three weeks old.

Photo. P. B. Kennedy.

Inoculation.

Inoculation is essential where these beans are being sown on land which has not previously grown a crop of Tick, Horse or Broad Beans, or has not previously grown a crop of peas. Cultures can be obtained at a small cost from the Plant

Pathologist of this Department for inoculating the seed just prior to planting. Full instructions with reference to the method of inoculating is sent out with the culture.

A typical root of horse bean.
Photos. P. B. Kennedy.

Single stalk of the horse bean showing 64 pods. Illustrating unusual large number of pods per stem.

Fertiliser.

An application of 2 cwt. to 3 cwt. of superphosphate is recommended per acre. On light sandy types of soils a small application, say ½ cwt. of sulphate of potash per acre would be advantageous.

Treatment After Sowing.

It is necessary to cultivate thoroughly between the rows to check weeds and conserve moisture which is required for the crop. This cultivation should be carried out until the beans are at least 6in. to 9in. high. From then on the beans are able to compete successfully with weeds.

Yields.

Very heavy yields of seed have been obtained from this bean under experiment, as much as 60 bushels per acre having been obtained during last season. The method adopted for harvesting is to cut when the bulk of the seed pods are just about dry, stook, then stack. Later the seed is thrashed out of the straw.

EXPORTATION OF APPLES AND PEARS.

SPECIAL REQUIREMENTS FOR 1940 SEASON.

The Secretary, Department of Commerce, has drawn attention to the fact that during the 1939 apple and pear export season, which is now drawing to a close, many consignments of apples and pears were packed in "Standard" boxes which did not comply with the specifications prescribed in the Exports (Fresh Fruits) Regulations.

Exporters and others interested in the supply to fruit growers of case material are advised that during the 1940 season "Standard" boxes for the export of apples and pears must conform to the following specifications:

Standard Apple Box.

(a) Each end shall be 11½ inches deep by 10½ inches wide by not less than ⅝ inch nor more than ¾ inch thick.

(b) Each side shall be 10½ inches wide by not less than 19¼ inches nor more than 19½ inches long. If made of soft wood, it shall be of one piece or two pieces 5/16 inch thick. If made of hard wood, it shall be of one piece ¼ inch thick or of two pieces 5/16 inch thick.

(c) The bottom shall be not less than 19¼ inches nor more than 19½ inches long. If made of soft wood, it shall be of two pieces each 5½ inches wide by 3/16 inch thick. If made of hard wood, it shall be of one, two or three pieces aggregating 11 inches wide by 3/16 inch thick. If a unitized bottom is used, it shall be of two, three or four pieces aggregating 11 inches wide by not less than ⅛ inch nor more than 3/16 inch thick.

(d) The top shall be not less than ⅛ inch nor more than ¼ inch longer than the bottom. If made of soft wood, it shall be of two pieces each 5½ inches wide by 3/16 inch thick. If made of hardwood, it shall be of one, two or three pieces aggregating 11 inches wide by 3/16 inch thick. If a unitized top is used, it shall be of two, three or four pieces aggregating 11 inches wide by not less than ⅛ inch nor more than 3/16 inch thick.

(e) A cleat shall be used at each end of the top and bottom and shall be not less than 11 inches nor more than 11½ inches long by not less than ⅝ inch wide by not less than 5/16 inch thick.

Standard Pear Box.

(a) Each end shall be 11½ inches wide by 8½ inches deep by not less than ⅝ inch nor more than ¾ inch thick.

(b) Each side shall measure 8½ inches wide by not less than 19¼ inches nor more than 19½ inches long. If made of soft wood, it shall be of one piece only, 5/16 inch thick. If made of hard wood, it shall be of one piece ¼ inch thick or of two pieces 5/16 inch thick.

(c) The bottom shall be not less than 19¼ inches nor more than 19½ inches long. If made of soft wood, it shall be of two pieces each 5½ inches wide by not less than 3/16 inch nor more than ¼ inch thick. If made of hard wood, the

bottom shall be of one, two or three pieces aggregating 11 inches wide by 3/16 inch thick. If a unitized bottom is used it shall be of two, three or four pieces aggregating 11 inches wide by not less than ⅛ inch nor more than 3/16 inch thick.

(d) The top shall be not less than ¼ inch nor more than ½ inch longer than the bottom. If made of soft wood it shall be of two pieces each 5½ inches wide by 3/16 inch thick. If made of hard wood, it shall be of one, two or three pieces aggregating 11 inches wide by 3/16 inch thick. If a unitized top is used, it shall be of two, three or four pieces aggregating 11 inches wide by not less than ⅛ inch nor more than 3/16 inch thick.

(e) A cleat shall be used at each end of the top and bottom and shall not be less than 11 inches nor more than 11½ inches long by not less than ⅝ inch wide by not less than 5/16 inch thick.

Special attention is invited to the requirement that the tops of the "Standard Apple Boxes" are required to be not less than ⅛ inch nor more than ¼ inch longer than the bottoms and in regard to "Standard Pear Boxes" not less than ¼ inch nor more than ½ inch longer than the bottoms. This is to provide allowance for bulge packing. Special attention is also drawn to the thicknesses of the top and bottom timber. These are:

Standard Apple.—Bottoms: 3/16 inch (or ⅛ inch to 3/16 inch if unitized). Tops: 3/16 inch (or ⅛ inch to 3/16 inch if unitized).

Standard Pear.—Bottoms: 3/16 inch (or ⅛ inch to 3/16 inch if unitized). Tops: 3/16 inch (or ⅛ inch to 3/16 inch if unitized).

Standard Apple Boxes must contain not less than 42 lb. weight of fruit, except in the case of large-sized apples and apples of light varieties.

Standard Pear Boxes must contain not less than 40 lb. weight of fruit.

THE COMPOSITION OF WHEAT AND OAT GRAIN GROWN IN WESTERN AUSTRALIA.

L. C. SNOOK, Institute of Agric., University of Western Australia.

Dadswell (1935), and Underwood and Snook (1935) have shown that Australian cereal grains are characterised by a low total ash content and may contain only half the phosphorus present in normal English or American grains. The series of analyses reported in the paper by Underwood and Snook (1935) have been continued and the additional data confirm the findings previously recorded. There is no need to duplicate the full description and discussion given in the earlier paper, but the full analytical data will be given here, along with a few supplementary comments.

The following Tables (Tables I.-VI.) show the variations in composition of wheat and oat grain, according to season and district where grown, over a period of five years. The three Agricultural Research Stations from which the samples were obtained represent distinct soil and climatic zones, but the cultural and manurial treatments of all the crops were similar.

Remarks.

The figures recorded in the various Tables (Tables I.-VI.) appear to supply definite proof that, in general, Western Australian cereals contain considerably less ash and only about half the phosphorus present in "standard" English and American grains. Grains from some districts such as Wongan Hills may be particularly deficient in phosphorus. The possible nutritional significance of this low phosphorus content has been discussed in another paper (Snook, 1938).

TABLE I.

WHEAT GRAIN.—THE COMPOSITION OF THE STANDARD "FAIR AVERAGE QUALITY" BLEND OF WESTERN AUSTRALIAN WHEAT.

(As a percentage of the dry matter.)

——	Year.	Nitrogen.	Crude Protein. (F = 5·83)	Total Ash.	Ca.	P.
F.A.Q.	1927	1·89	11·03	1·67	0·04	0·23
	1929	2·06	12·01	1·55	0·04	0·22
	1930	1·90	11·08	1·53	0·05	0·24
	1933	1·91	11·14	1·46	0·04	0·22
	1934	2·05	11·95	1·35	0·03	0·23
	1935	1·84	10·72	1·38	0·04	0·27
	1936	2·08	12·13	1·43	0·04	0·26
Average	...	1·96	11·43	1·48	0·04	0·24
"Standard" English Wheat (Marshall & Halnan, 1932) ...	...	2·44	14·22	1·96	0·05	0·47

TABLE II.

COMPOSITION OF GRAIN GROWN AT MERREDIN RESEARCH STATION.

(As a percentage of the dry matter.)

——	Year.	Nitrogen.	Crude Protein. (F = 5·83)	Total Ash.	Ca.	P.	Rainfall during May-Oct.
							inches.
Wheat (variety "Nabawa")	1932	2·10	12·25	1·64	0·04	0·28	11·13
	1933	2·37	13·81	1·61	0·035	0·24	9·51
	1934	2·44	14·22	1·50	0·04	0·24	6·44
	1935	2·58	15·04	1·54	0·035	0·27	7·64
	1936	3·64	21·22	1·79	0·05	0·33	7·03
Average	...	2·63	15·33	1·62	0·04	0·27	...
			(F = 5·83)				
Oats (variety "Mulga")	1932	2·00	11·66	3·94	0·06	0·24	11·13
	1933	1·96	11·43	3·11	0·05	0·21	9·51
	1934	2·00	11·66	3·04	0·07	0·22	6·44
	1935	1·99	11·60	2·74	0·06	0·25	7·64
Average	...	1·99	11·60	3·21	0·06	0·23	...

(The total ash of the oat grain contained about 40% to 45% SiO_2.)

TABLE III.

COMPOSITION OF GRAIN GROWN AT WONGAN HILLS RESEARCH STATION.

(As a percentage of the dry matter.)

—	Year.	Nitrogen.	Crude Protein. (F = 5·83)	Total Ash.	Ca.	P.	Rainfall during May-Oct.
							inches.
Wheat (variety "Nabawa")	1932	1·48	8·63	1·53	0·05	0·24	16·27
	1933	1·63	9·50	1·55	0·04	0·20	12·60
	1934	1·71	9·97	1·4	0·035	0·24	9·26
	1935	1·64	9·56	1·16	0·035	0·19	9·71
	1936	1·53	8·92	1·20	0·04	0·23	8·78
Average	...	1·60	9 33	1·37	0·04	0·22	...
			(F = 5·83)				
Oats (variety "Mulga")	1932	1 40	8 16	3·46	0·06	0·23	16·27
	1933	1·37	7·99	3·54	0·06	0·21	12·60
	1934	1·60	9·33	2·80	0·06	0·17	9·26
	1935	1·42	8·28	2·95	0·07	0·19	9·71
Average	...	1 45	8·45	3·19	0·06	0·20	...

(The total ash of the oat grain contained about 50% SiO_2.)

TABLE IV.

COMPOSITION OF GRAIN GROWN AT CHAPMAN RESEARCH STATION.

(As a percentage of the dry matter.)

—	Year.	Nitrogen.	Crude Protein. (F = 5·83)	Total Ash.	Ca.	P.	Rainfall during May-Oct.
							inches.
Wheat (variety "Nabawa")	1932	1·75	10·20	1·58	0·04	0·28	17·16
	1933	1·55	9·04	1·64	0·025	0·37	18·96
	1934	1·81	10·55	1·7	0·05	0·37	13·51
	1935	1·72	10·02	1·66	0·04	0·31	10·13
	1936	1·67	9·74	1·60	0·04	0·30	14·27
Average	...	1·70	9·91	1·64	0·04	0·33	...
			(F = 5·83)				
Oats (variety "Mulga")	1932	1·27	7·40	4·07	0·09	0·26	17·16
	1933	1·73	10·09	3·60	0·05	0·32	18·96
	1934	1·28	7·46	3·71	0·08	0·27	13·51
	1935	1·56	9·09	3·24	0·07	0·22	10·13
Average	...	1·46	8·51	3·66	0·07	0·27	...

(The total ash of the oats grown in 1935 contained about 54% SiO_2.)

TABLE V.

COMPOSITION OF OAT GRAIN (VARIETY "MULGA") GROWN AT NUNGARIN.

(As a percentage of the dry matter.)

Year.	Nitrogen.	Crude Protein. (F = 5·83)	Total Ash.	Ca.	P.	Rainfall during May-Oct.
						inches.
1932	2·09	12·21	3·88	0·06	0·24	10·98
1933	1·88	10·96	3·03	0·07	0·24	8·36
1935	2·66	15·51	3·23	0·07	0·31	7·10
Average	2·21	12·88	3·38	0·07	0·26	...

(The total ash of the oat grain grown in 1935 contained about 34% SiO_2.)

TABLE VI.

AVERAGE COMPOSITION OF WESTERN AUSTRALIAN CEREAL GRAINS.

(As a percentage of the dry matter.)

District in which Sample was grown.	Total Nitrogen.	Crude Protein. (F = 5·83)	Total Ash.	Ca.	P.	No. of Years Averaged.
Wheat—						
Merredin	2·63	15·33	1·62	0·04	0·27	5
Wongan Hills	1·60	9·33	1·37	0·04	0·22	5
Chapman	1·70	9·91	1·64	0·04	0·33	5
"Fair Average Quality" ...	1·96	11·43	1·48	0·04	0·24	7
"Standard" English (Marshall & Halnan)	2·44	14·22	1·96	0·05	0·47	...
Oats—		(F = 5·83)				
Merredin	1·99	11·60	3·21	0·06	0·23	4
Wongan Hills	1·45	8·45	3·19	0·06	0·20	4
Chapman	1·46	8·51	3·66	0·07	0·27	4
Nungarin	2·21	12·88	3·38	0·07	0·26	3
"Standard" English (Marshall & Halnan)	1·90	11·08	3·57	0·10	0·39	...
Scottish ("Victory"), Aberdeen, 1936	1·52	8·86	3·26	0·10	0·42	...

The protein content of wheat and oat grain, of the same variety for each species, varies considerably according to district of origin. This may be of some importance where grain is purchased for stock-feed, as during the long summer months many grazing animals in Western Australia receive inadequate supplies of protein and the protein in grain supplements may be of considerable significance in maintaining good health. The findings of Csonka (1937) are of interest in this regard. He reports that the quality of the protein in wheat grain improves as the total content of the grain rises. Where wheat protein is of value in supplementary feeding it seems that cereals grown in the eastern wheat-belt (the areas including Merredin and Nungarin) will be worth more than cereals grown at Wongan Hills or Chapman.

The grain of "Nabawa" wheat contains more crude protein than that of "Mulga" oats grown on the same farm. As there is little qualitative difference between the protein in the two cereals (see "Wheat," 1936) the oat grain commonly used as stockfood can be replaced as required by wheat whenever relative prices warrant the substitution. Wheat grain is a safe and palatable foodstuff for stock, if used correctly (see Snook, 1933).

Efforts were made to discover some correlation between rainfall and the total nitrogen content of the cereal grains. No such relationship is apparent. Climate is undoubtedly an important factor in determining the protein content of wheat grain but it seems that in the samples under review, other variables mask the climatic effects. There seems to be no constant relation between the varying amounts of protein found in wheat and oat grain from the same farm in different years. The protein contents of the two grains appear to be controlled by different factors.

TABLE VII.

SHOWING THE RELATIVE SIZE OF THE VARIOUS GRAINS.

District in which Sample was grown.	Mass of a 1,000 grains.	Percentage Nitrogen.
Wheat—	grams.	%
Merredin, 1935	51·5	2 58
Merredin, 1936	54·6	3·64
Wongan Hills, 1936	51 1	1·53
Chapman, 1936	62 7	1 67
Nungarin, 1936	40 2	2·76
Oats—		
Wongan Hills, 1935	44·9	1·42
Nungarin, 1935	22·0	2·66
Scottish, 1936	53·1	1 52

It is known that wheat grain which has been shrivelled by hot dry weather during the ripening period, is generally of high protein content. It can be seen from Table VII. that the high protein content of the Merredin samples is not due to "shrivelling": in fact, the samples as analysed from this centre consisted of grains of large size and excellent appearance. Dadswell (1935) determined the weight of 1,000 grains from each of 23 samples of Victorian wheat, and the average value for the series was 40.4 grams per 1,000 grains (range 49.5-34.5). If this figure is typical the Western Australian grains seem plump in comparison.

The oat grain grown in the eastern districts of Western Australia, however, would be considered of very poor quality by farmers familiar with the plump grains, with a minimum of husk, grown in moister climates. None-the-less, it can be seen that the thin, husky, Nungarin oat (Table V.) contains more crude protein than the attractive Scottish oat of double the size. Oat grain is held in high esteem by Western Australian farmers as a stock food, and this esteem may not be unconnected with a high crude protein content.

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CLEAN MILK COMPETITION, BRUNSWICK, 1938-39.

M. CULLITY.

In view of the success attending previous clean milk competitions, carried out in this State, at Balingup, Manjimup and Serpentine, Messrs. Brownes, Ltd., of Brunswick, decided to offer prizes for the best milk delivered at their receiving depot and cheese factory as shown by periodic examinations of the milk from each supplier. A trophy was also offered to the farmer who marketed milk of the highest average quality during the whole period during which the competition was being held.

In order to facilitate operations, judging was confined to a survey of the amount and type of sediment in the milk as disclosed by the use of the sediment test, and the number of bacteria as shown by a direct count. Points were allotted according to the following scale at each inspection:—

Sediment	20	points.
Bacteria	100	,,
Total	120	,,

The score for bacteria was not in proportion to the number of organisms present but according to the following scale, which was adopted as giving a fairer basis because of the greater rapidity of increase in numbers of a highly contaminated sample as compared with one not so badly contaminated. This was necessary as the unavoidable time lag between milking and the collection of the samples was lengthened by the necessity of conveying the samples to Bunbury without cooling. As the time at which the slides were prepared was nearly 11 a.m. on each occasion, it will be realised that a survey of the actual counts would not give an accurate indication of the condition of the milk as it was received at the depot.

The scale for the allocation of points for bacteria was as follows:—

	points.
10,000 bacteria /cc. and under	100
10,000 to 31,000 bacteria /cc.	95
31,000 ,, 100,000 ,, ...	90
100,000 ,, 310,000 ,, ...	80
310,000 ,, 1,000,000 ,, ...	70
1,000,000 ,, 3,100,000 ,, ...	50
3,100,000 ,, 10,000,000 ,, ...	25
over 10,000,000 ,, ...	0

In order to familiarise the suppliers with the procedure of sampling and to give them some idea of the quantity of the milk produced on their farms, a trial test was made. Samples for the competition were then collected on the following dates: 14th October, 28th October, 22nd December, 1938, and 1st February, 1939.

The general results for the individual suppliers are as indicated in Table 1.

That the quality of the milk improved during the competition is shown by block "a." It should be remembered that samples were collected at irregular intervals and without notice. The latest series of samples was taken during the summer months, when the weather conditions would be conducive to dust in the atmosphere of the milking yards and more rapid multiplication of bacteria in the

milk because of the higher temperatures. Milk from three farms declined in quality during the period, probably due to the conditions mentioned rather than a decline in the methods used.

TABLE I.

—	Inspection 1. 14-10-38			Inspection 2. 28-10-38			Inspection 3. 22-12-38			Inspection 4. 1-2-39			Grand Total.
	S.	B.	T.	S.	B.	T.	S.	B.	T.	S.	B.	T.	
D. Harding (3)	0	95	95	16	80	96	16	95	111	14	90	104	406
T. Stanley (10)	14	70	84	13	70	83	9	90	99	9	90	99	365
A. S. Warburton (2)	8	90	98	14	70	84	9	70	79	16	80	96	357
W. Reeve (12)	10	70	80	8	50	58	14	80	94	13	80	93	325
8	12	50	62	7	80	87	12	90	102	10	25	35	286
4	0	80	80	10	25	35	7	70	77	10	80	90	282
17	8	70	78	8	50	58	10	80	90	8	25	33	259
7	14	25	39	15	70	85	9	25	34	16	80	96	254
13	12	0	12	3	25	28	11	90	101	11	70	81	222
5	13	25	38	12	25	37	16	50	66	15	50	65	206
1	3	0	3	9	70	79	7	25	32	10	80	90	204
6	15	0	15	11	0	11	14	80	94	8	70	78	198
9	9	25	34	8	50	58	7	0	7	15	70	85	184
15	14	70	84	12	50	62	7	25	32	...	...	...	178
19	0	50	50	0	90	90	8	25	33	...	..	..	173
16	8	0	8	11	70	81	10	70	80	...	.	...	169
11	12	50	62	13	25	38	11	25	36	8	0	8	144
14	9	25	34	7	25	32	8	0	8	6	25	31	105
18	9	25	34	0	50	50	7	0	7	7	0	7	98

S. = Sediment. B. = Bacteria. T. = Total.

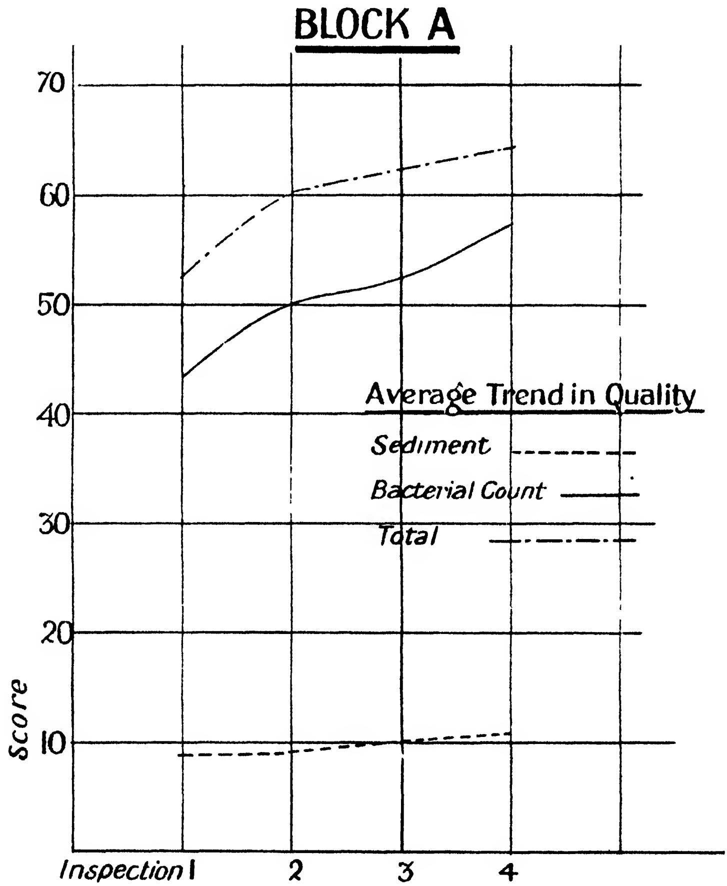
Block "b" shows a comparison between the trends in quality of four groups of milks, including one group representing those declining in quality. The curve for the average of all milks is used as a standard. It will be seen that the average of the remainder when the three which declined in quality are withdrawn shows a very steady rate of improvement. This illustrates very well the effect a few poor quality samples have on a number. The rapid improvement following instruction where the incentive to improve is present is also illustrated. The farms of the suppliers of the four lowest quality milks at the time of the first inspection were visited, after the second series of samples were collected. The block indicates that the milk from these farms was of equal quality to the remainder at the third inspection. The readiness with which the advice was adopted was a good demonstration of the natural desire of the average farmer to produce a high quality article.

Mastitis:

One alarming aspect of the competition was the large number of milks with high leucocyte counts, which probably indicates the presence of mastitis in the majority of the herds. It is probable that the use of milking machines without regular precautionary examination of the cows is contributing to the spread of the disease. It is suggested that apart from any other consideration, and there are others, that each cow be started, that is, made to let the milk down before attaching the teat cups. This allows the milker to examine the milk and the udder for any abnormalities. When any defect is apparent the cow should be put out of the shed and milked, preferably by hand, when the remainder of the herd has been finished.

Hand versus machine milking:

The results indicate that most of the milking machines were being operated in a reasonably clean manner In previous competitions of this nature, hand produced milk figured prominently in the results. In this case, however, the hand milking dairies filled the second, fifth, seventh, thirteenth, fourteenth and sixteenth places among the sixteen competitors who took part in the four inspections. The spread in quality of both hand and machine produced milk appears to indicate that there is not any considerable advantage in either method for producing a clean milk under our average farm conditions.



Value of proper knowledge of care of a milking machine:

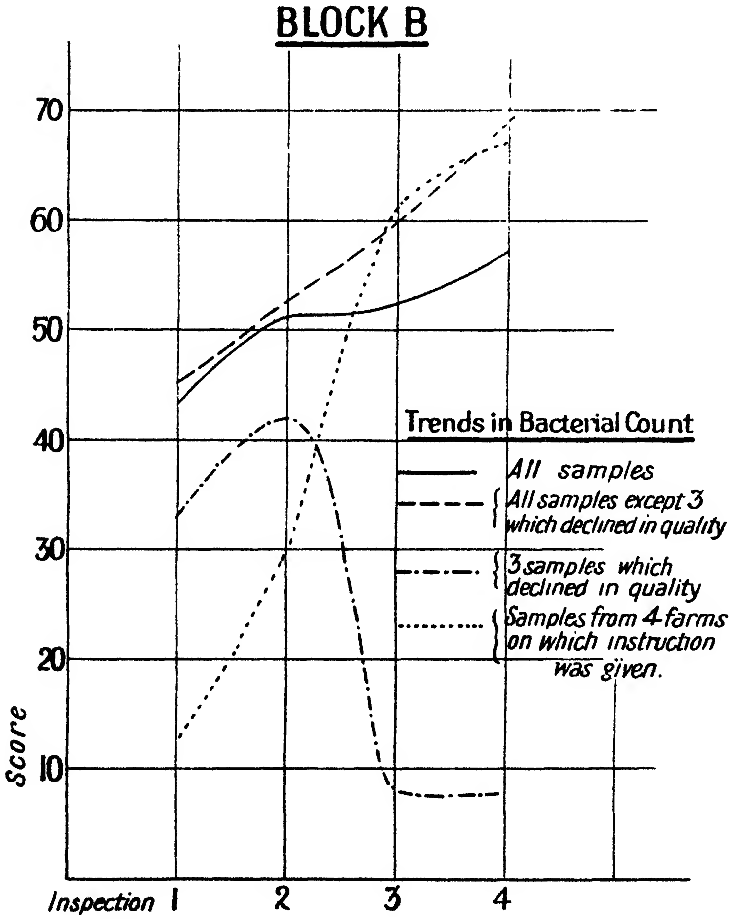
As indicated previously, those farmers who were visited eventually succeeded in producing a greatly improved milk. In each case the reason for the failure to produce milk of good quality could be attributed not to carelessness on the part of the farmer, but to a misunderstanding of the principles of dairy cleansing, particularly of those surfaces which could not be inspected, such as the interior of rubber tubes, milk pipes, etc.

In view of the impossibility of visiting all of the farms, an attempt was made to stimulate improvement by conversation at the depot and by the display of a

chart, showing the effect of various practices related to the production and handling of milk.

Correlation between sediment test and bacterial count:

From a perusal of Table 1, it appears obvious that there is no connection between the result of a sediment test and the number of bacteria that may be present in the milk. In block "a" it will be noticed that an improvement of both sediment tests and bacterial counts occurred during the competition. While the curves follow similar routes, a comparison of the results from individual farms appears to indicate that the similarity is one only of improved quality rather than a direct relationship between the amount of sediment and the number of bacteria. The use of the sediment test, however, was useful in promoting a sense of dairy hygiene, and for this reason can be highly commended.



Acknowledgments must be made of the assistance of the South-West Co-operative Dairy Farmers, Ltd., who agreed to their bacteriologist carrying out the bacterial counts, and to Mr. D. G. Griffin for actually doing this work. Acknowledgment is also made to Mr. H. Kretchmar for suggestions regarding the method of allocation of points for bacterial content.

THE SHEEP BLOW-FLY PROBLEM.

C. F. H. JENKINS,
Government Entomologist.

Much research work has been done on the blow-fly problem during the last few years by the Council for Scientific and Industrial Research and the various State Departments of Agriculture, and the ensuing article is an attempt to present in a form useful to the farmer, the more important results of this work.

During the past autumn the blow-fly has been particularly active in the pastoral and farming areas, and the percentage of fly-strikes has been higher than for a number of years past. Complaints have reached this Department from various centres stating that a new fly has made its appearance in the district and that it is characterised by the fact that it attacks the back and loins of the sheep, rather than the crutch.

The high incidence of body strike has certainly been a feature of the season's infestations, but from the ensuing article it will be seen that environmental conditions and not any particular kind of fly, were responsible for this.

TYPES OF FLIES.

The flies which attack sheep may be divided into three groups according to the part they play in the phenomenon known as fly strike, and the recognition of this grouping is important for the understanding of how blow-fly strike and the resultant myiasis is brought about.

Firstly, there are what are known as primary flies. These are able to initiate a strike on a living animal.

Secondary flies are those which normally are incapable of initiating a strike, but which follow the primary flies and take advantage of the conditions set up by their maggots.

Tertiary flies produce maggots which feed upon the matted wool or around the scabs of wounds and so have little economic bearing.

List of Flies which may be found attacking Sheep in Western Australia.

Primary Flies.

Lucilia cuprina Wied. (Primary Green Blowfly).
Lucilia sericata Meigi. (European Green Blowfly).
Calliphora nociva Hardy (The Blue-tailed Blowfly).
Calliphora australis Bd. (Western Australian Blowfly)).

Secondary Flies.

Chrysomyia rufifacies Mcq. (Secondary Green Blowfly).
Microcalliphora varipes Mcq. (Small Green Blowfly).
Sarcophaga sp.

Tertiary Flies.

Peronia rostrata R.-D.
Musca domestica Linn.

The following is a superficial description of the more important species likely to be met with by the farmer.

The Green Blowflies, sometimes known as Blue Bottles.

Lucilia cuprina (The Primary Green Blowfly).

This introduced insect is a bright, metallic green often with a coppery tinge; the eyes are red and the face and cheeks silvery white. The legs are black, with the exception of the thighs of the front pair, which are bright green. This feature is of particular importance as it distinguishes this species from the succeeding one.

The larva or maggot is smooth and cream-coloured; the puparium is smooth and barrel-shaped.

Lucilia sericata (The European Green Blowfly).

This fly is also an introduced species and very similar to the foregoing, but can be recognised by the fact that the thighs of the fore-legs are black like the other legs, and not green as in *L. cuprina.*

The other stages of the fly resemble very closely those of *L. cuprina.*

Chrysomyia rufifacies (The Secondary Green Blowfly).

This species is very similar in general appearance to the two preceding flies, and may easily be confused with them. It is, however, rather stouter in build and has a slightly bluish tinge on the abdomen. The most characteristic feature is a narrow dark band marking the posterior of each abdominal segment and giving the abdomen a faintly banded appearance.

The maggots are brownish-grey in colour and provided with fleshy outgrowths which have caused them to be popularly known as "hairy maggots" as opposed to the smooth larvae of the primary flies. The puparium is greyish brown and has a rugged exterior.

Microcalliphora varipes (The Small Green Blowfly).

This is a much smaller fly than the other green flies described and may further be distinguished by the legs which are banded black and light brown.

The maggots and pupae are smaller than those of *Chrysomyia rufifacies.*

The Brown Blowflies.

Two species of brown blowflies are commonly met with in Western Australia, both are primary flies with smooth, cream-coloured maggots.

Calliphora nociva (The Blue-tailed Blowfly).

This fly can be distinguished from the Western Australian brown blowfly by the yellowish-brown abdomen, the terminal and dorsal portions of which are occupied by a metallic, steel-blue patch.

Calliphora australis (The Western Australian Brown Blowfly).

This fly is sometimes called the Golden Winter Blowfly. It is a robust species characterised by the presence of golden yellow patches of fine hairs on the abdomen.

Relative Importance of Different Species.

Investigation has shown (Mackerras 1936) that *Lucilia cuprina* is by far the most serious sheep blowfly in Australia, approximately 80 per cent. of strikes being attributable to this insect; next important of the primaries in this State is *Calliphora nociva*, followed by *C. australis.*

The most important secondary species is *Chrysomyia rufifacies* which is of considerable economic importance on account of its ability to follow on a primary strike and further aggravate the wound.

Life History.

The eggs of the Primary Green Blowfly will hatch under favourable conditions in 12 to 24 hours (Mackerras 1936). The maggots feed up to six days and then may roam away from their food to pupate. This stage lasts about eight days following which the adult fly emerges and, under normal conditions, is ready to lay eggs in about another five days. Batches of eggs from 150-250 in number may be laid every few days for a period of over a month so that two or three thousand eggs can be laid by a single female.

Seasonal and Regional Incidence.

In the winter time most of the flies are dormant, the Calliphoras being the most active in the cold weather. With the advent of warmer conditions, the primary green flies appear and in the hotter months the secondary green blowfly is predominant. *Lucilia cuprina* occurs throughout most of the farming and pastoral areas. The Calliphoras are typically southern in their distribution, although *C. nocira* has a more extensive range than *C. australis.*

Factors Inducing Strike.

One of the most important factors affecting fly strike is the weather. Warm and damp conditions are very favourable, as most sheepmen have learned to their cost, and it is because of this fact that such severe trouble has been experienced this season.

An area to be struck must be wet for some time and this accounts for the higher percentage of body strike during wet weather. In drought years fly strike is not serious with us and the majority of strikes are crutch and tail strikes where the wool has been wetted by urine, etc., but in wet years the back, loins, etc., may be sufficiently moist to induce strike and so we have a bad fly year. The abundance of green feed is also an important factor.

Prevention of Strike.

This may be attempted in two ways: naturally, that is by breeding non-susceptible sheep; or artificially, by treating the sheep in such a way as to render them unattractive to flies.

The first method is the one which is most desirable, but one which can only be done by degrees.

Seddon, Belschner and Mulhearn (1931) have demonstrated that wrinkly sheep are predisposed to fly strike and that such undesirable or C class sheep can in time be eliminated from a flock by culling. It has also been shown that yellow, greasy fleeces are undesirable from the point of view of fly strike as well as for other reasons.

Artificial Treatment.

The Mules Operation.—This is a quick way of converting C class or wrinkly breeched sheep into non-susceptible types.

The breech folds and any other distortions liable to cause contamination of the crutch are surgically removed.

This operation has much to recommend it, but it must be remembered that the resultant wounds are often liable to infection, and the practice should be

looked upon only as a temporary expedient and not one which can be used to supplant culling. It also has the disadvantage of making culling more difficult, as treated sheep may be confused with naturally non-susceptible types, and so kept for breeding.

Crutching.

This is probably the most effective and most widespread preventive measure in use. The wool should be shorn closely from above the tail, around the breech and down the back legs. A sheep in this condition is not attractive to flies and in some districts in addition to the usual crutching before lambing, an additional treatment may be given if a bad fly season is expected.

Jetting.

The most recent jetting fluid recommended is that used by R. N. McCulloch of the New South Wales Agricultural Department consisting of a calcium arsenite mixture (Annon 1939).

The method of preparing this mixture which is used at the rate of 10 lbs. of white arsenic, 10 lbs. of stone lime (calcium oxide), and 1 lb. of caustic soda to 100 gallons of water (10 : 10 : 1 : 100) is as follows:

Place a four-gallon bucket full of water on a fire. Into another bucket weigh ½ lb. of caustic soda and secondly 4 lb. of white arsenic (arsenious oxide). Weigh out separately 4 lbs. of stone lime.

When the water is boiling, pour half the contents into the bucket of soda and arsenic, and place on the fire to continue dissolving the arsenic. Into the remaining water drop the stone lime lump by lump, and stir it as slaking takes place. Stand the slaked lime near the fire. When the arsenic-soda liquid is clear, but still boiling, lift from fire and pour into it a half bucket of boiling milk of lime. This should not be done too rapidly, as the ingredients react violently and may boil over. Place the mixture by the fire to simmer for 15 minutes.

This will make 40 gallons of 1 per cent. arsenic fluid for use.

The success of jetting depends largely upon the method of application. The object is to saturate the wool around the breech and to obtain this result pressure is necessary. Too high a pressure may produce skin injury, and treatment too soon after crutching is unwise due to the possibility of poison absorption by shear cuts, and the scant amount of wool present to absorb the fluid. The pressure required depends upon the growth of wool present, but varies from "about 100 lbs. per square inch on sheep with six weeks' wool to 130 to 150 lbs. for sheep carrying three to six months' wool." (Belschner, 1937.)

Trapping.

The efficiency of trapping as a control of blowflies was tested by the C.S. & I.R. both in New South Wales and in this State at "Cranmore Park." near Walebing. (Mackerras, Fuller, Austin & Lefroy, 1936.)

Two very similar areas were chosen at a suitable distance from one another and stocked with selected sheep. One area was intensively trapped and the other used as a control. Over a two-year period it could be shown that less strike was prevalent in the trapped paddock than in the untrapped, but whether this method is an economic proposition under normal pastoral conditions has still to be demonstrated.

The traps used were the Western Australian blowfly traps and it was found that the most attractive bait was liver to which was added about a pint of sodium sulphide liquid, mixed at the rate of three ounces of chemical to one gallon of water.

Wound Dressings.

A large number of mixtures have been advocated for treating strike wounds, but very few give results which can be regarded as at all satisfactory, and up to the present no lasting repellent has been found for incorporation in such dressings.

Mixtures advocated by the Joint Blowfly Committee are—

(i) 5 per cent. watery solution of zinc sulphate,
(ii) 5 per cent. watery solution of "Monsol,"
(iii) 4 per cent. phenol (carbolic) crystals in whale oil,

and the latest mixture evolved by the C.S. & I.R. is the glycerine-boric acid dressing prepared by dissolving 3 lbs. of boric (boracic) acid in 1 gallon of glycerine. (If the glycerine is warmed the process will be facilitated.)

To obtain the best results from any dressing it is necessary to shear all wool from around the wound and to make a careful examination to see that no small isolated pockets are overlooked. As many of the maggots as possible should be removed and the dressing thoroughly applied so as to reach all affected parts.

Disposal of Carcases.

Burning.—This method if thoroughly carried out is a most effective method of blowfly control, but it has the disadvantage of being laborious.

Burying.—Owing to the fact that primary maggots are able to emerge through up to 10 feet of soil, burying infested carcases is not an effective way of controlling blowflies, and as the secondary maggots are not able to penetrate the soil as easily as their smooth relatives, burying really favours the primary flies. This is undesirable when we realise that the secondary maggots will actually devour the primary maggots in a carcase and so assist in controlling the smooth-maggot flies.

If carcases are buried for sanitary reasons, they should also be poisoned.

Poisoning.—This is the easiest and most satisfactory method of treating carrion; a liberal sprinkling on both sides of a carcase with some arsenical powder, such as sheep dip, will successfully prevent the breeding of blowflies.

Biological Control.

Several attempts at controlling blowflies by parasites have been attempted by this Department, but without success.

A number of foreign wasps have been tried as well as a local species, but in no instances were encouraging results obtained. (Newman & Andrewartha, 1930.)

Summary.

1. Blowflies are divided into two main groups—primaries and secondaries.

2. Lucilia cuprina (the Primary Green Blowfly) is by far the most dangerous sheep blowfly.

3. Factors influencing the incidence of fly strike are weather conditions, the presence of green feed, and the type of sheep. Humid conditions, an abundance of green feed, and wrinkly or C class sheep are favourable to strike.

4. *Prevention of Strike.*—Strike may be minimised by—

(a) Breeding non-wrinkly sheep.
(b) Removing breech folds, etc., surgically (Mules operation).
(c) Crutching.

(d) Jetting with calcium arsenite (10 : 10 : 1 : 100).
(e) Application of suitable wound dressing.

5. *Carcase Disposal.*—This may be most effectively done by treatment with an arsenical powder such as sheep dip.

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NOTES ON SOIL EROSION IN THE NORTHERN AGRICULTURAL AREAS.

By L. J. H. TEAKLE.

At the request of the Mingenew Road Board and the Northern Zone Council of the Wheat and Wool Growers' Union of Western Australia, a reconnaissance of the Mingenew, Yandanooka, Carnamah, Perenjori and Morawa districts with respect to soil erosion was made in company with Mr. N. Davenport, the Agricultural Adviser for the district, during July, 1938. Lectures on soil erosion were given at various centres, and methods for the construction of contour banks for the control of soil erosion by water action were demonstrated at Yandanooka and Carnamah. In addition to general observations throughout the area, a detailed survey of the incidence of soil erosion was made on the property of Mr. J. A. Brown, "Raith," Yandanooka Lot 104, Yandanooka.

WATER EROSION.

Throughout the area, it was observed that water erosion was causing some damage where slopes in cleared land exceeded 3 to 3½ per cent. The erosion manifested itself largely in the form of gutters which interfere seriously with the working of the farms under modern methods. Sheet and rill erosion, while present and severe in some instances, were not extensive. The amount of land actually destroyed did not appear to be very large in the aggregate, but gutters cutting through the paddocks in undulating country and opening out on to the fertile flats, are most undesirable where big machinery is being used in the production of wheat.

Enquiries from many farmers showed that the first signs of soil erosion generally appeared within five to 10 years after clearing. In the first five years the physical properties of the soil are such that erosion does not occur to any extent even in very wet years. Following some years of cultivation, erosion develops rather rapidly and lands under fallow or newly sown wheat are most liable to damage during the early winter months.

Some measure of soil wastage as a result of water erosion is afforded by an estimate of the sediment carried by a small stream, which was made at Mingenew where the Lockier River was sampled on July 20th, 1938. At that time this stream carried about the normal winter flow estimated at 50 cubic feet per second. The water was quite muddy and an analysis showed that it carried 0.74 per cent. suspended matter, principally good red soil. This is equivalent to approximately 6.8 acre inches per 24 hours.

WIND EROSION.

In Western Australia wind erosion is generally most severe on light sandy soils. The more sandy types of sandplain country under cultivation suffer most severely, and sandy surfaced timber types may be damaged unless cultivated immediately after burning up is completed and care is taken to protect the surface in subsequent operations. In the Yandanooka area, however, where the farms are generally relatively small in area, wind erosion has become serious on the fertile flats, particularly during the years 1934-1937 inclusive. As a result of a period of low rainfall years with consequent reduction in feed production, serious overstocking has occurred. This has been accentuated by a grasshopper plague, and wind erosion has assumed damaging proportions on a number of farms. An improved system of management, involving a less severe programme of cultivation and lighter stocking, will be necessary in order to restrict the damage resulting from wind action.

A DETAILED SURVEY OF THE EFFECT OF WATER EROSION.

In order to obtain precise information concerning the incidence of soil erosion on an affected farm, a careful survey was made on the property of Mr. J. A. Brown, Yandanooka. This farm lies in the range of low hills along the western boundary of the Yandanooka valley. These hills are largely of Jurassic sandstone and conglomerate with out-crops of limestone.

From the sandstones are developed an attractive range of chocolate brown to brownish red soils of a sandy loam texture and with reddish clay subsoils. Patches of heavier textured soils, usually of a crabhole or gilgai formation, occur. These soils are eminently suited for wheat and sheep farming and have proved very productive. In general, it is observed that, in common with other Western Australian types derived from sedimentary rocks, they are somewhat

more prone to wind erosion than those of granitic origin, but do not appear any more liable to water action than are the granitic types. They may be regarded as quite typical of the better classes of soils in the red brown earth zone or jam-York gum belt of Western Australia.

The limestone occurs generally as cappings either on the hills or on the gentler slopes. The soils associated with the limestone are typically very stony and generally non-arable. Normally, these limestone areas afford quite good grazing and provide valuable shelter for stock when not cleared.

While situated in hilly country, about 75 per cent. of the area of this farm is undulating and quite suitable for arable farming as in these portions the slopes would seldom exceed 5 per cent. The remainder of the area, however, is either stony or steep. Slopes as high as 30 per cent. are encountered and 10 per cent. slopes are common. Topographically these hilly areas present a juvenile appearance with steep-sided gullies and grykes opening out into the flatter country.

In the virgin state this area carried principally jam (*Acacia acuminata*) and York gum (*Eucalyptus foecunda var. loxophleba*) timber, with curara (*Acacia* sp.) and needle bush (*Hakea* sp.) as undergrowth, and was quite well grassed. On the limestone ridges, jam and wattle (*Acacia* sp.) appear to have predominated and on the stony sandstone and conglomerate hills, sheoak (*Casuarina* sp.) and a variety of shrubs, including *Commersonia pulchella*, *Ruelingia luteiflora* and *Hemigenia Drummondii* are common. Flooded gum (*Eucalyptus rudis*) commonly occurs along the creeks.

The rainfall since 1922 is given in the following table:—

RAINFALL DATA FOR THE YANDANOOKA DISTRICT.

1922–1939

Year	Jan	Feb	Mar	Apl.	May	June	July	Aug	Sept	Oct	Nov.	Dec.	Total
1922	3	64	39	155	100	208	361	125	93	15	*Nil*	12	1,175
1923	52	98	10	165	137	809	298	155	184	41	*Nil*	*Nil*	1,949
1924	*Nil*	5	43	5	160	361	468	253	80	169	35	*Nil*	1,579
1925	146	14	*Nil*	*Nil*	278	451	257	93	232	46	10	68	1,595
1926	*Nil*	11	17	183	173	298	516	202	165	171	132	75	1,943
1927	*Nil*	23	407	33	175	345	453	199	186	21	2	120	1,964
1928	30	3	40	21	279	175	460	231	120	78	5	174	1,616
1929	*Nil*	58	25	7	415	536	205	207	48	18	131	1	1,651
1930	*Nil*	*Nil*	22	30	137	902	391	154	123	96	15	5	1,875
1931	*Nil*	*Nil*	41	57	517	187	465	212	209	68	253	46	2,055
1932	55	*Nil*	199	128	421	256	439	662	119	132	7	28	2,446
1933	11	17	71	19	314	614	253	391	99	129	46	36	2,000
1934	182	*Nil*	449	569	69	331	325	277	92	23	14	37	2,368
1935	151	71	137	196	68	111	487	309	91	51	3	6	1,681
1936	4	11	27	64	137	305	165	242	74	43	68	25	1,165
1937	8	11	2	205	334	285	44	243	119	18	21	14	1,304
1938	*Nil*	20	105	152	70	118	437	151	80	27	58	*Nil*	1,218
1939	124	176	1	11	280								

It is quite adequate for mixed farming of the type practised in the red brown earth zone in Western Australia.

The Yandanooka area was subdivided for soldier settlement and this holding was taken up by Mr. Brown in 1922. Prior to subdivision, the Yandanooka Estate had attained a very high reputation for grazing value and cultivation had not been highly developed. With the influx of soldier settlers, extensive clearing operations were adopted and, in a few years, the bulk of the area had been cleared and was under cultivation. On account of the small size of the holdings, a fallow-wheat rotation, the most exhaustive of all possible rotations, was generally adopted and no effort was made to allow a period under pasture for the regeneration of the soils. Generally, the bulk of the timber was left on the rough limestone out-

crops, but on the areas of better soil the timber was removed in the course of the development of the farm. Even on very steep slopes, slopes in excess of 10 per cent. and too steep for the use of cultivating implements, clearing of timber was practically complete to promote the growth of pasture plants Fig. 1 shows the steep slopes, practically devoid of timber and herbage, which are the starting point of several deep gullies in the south-eastern portion of the farm.

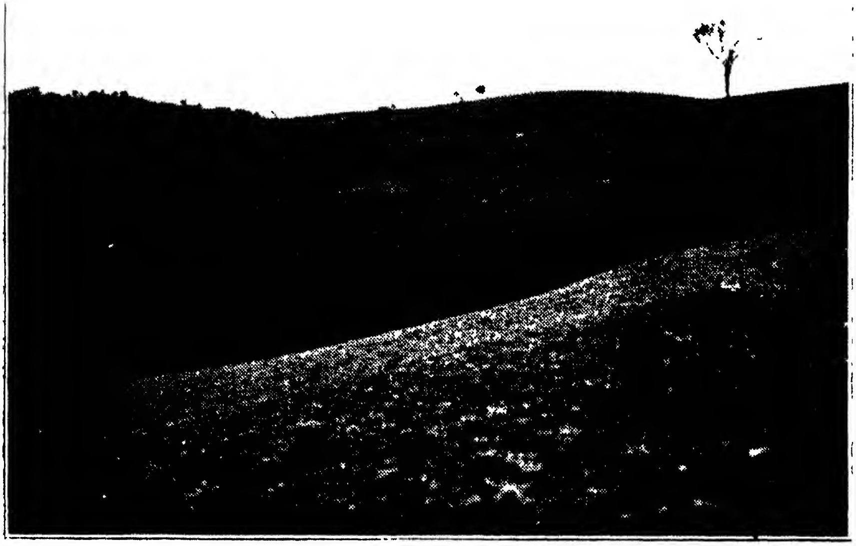


Fig. 1.—Steep slopes, practically devoid of timber and herbage, on the south-eastern portion of Yandanooka Lot 104, which are the starting point of several deep gullies which cut through valuable arable land on this farm and the property immediately eastward.

The first signs of water erosion on this property, in the form of gullies, were observed in 1927, about 5 years after clearing. Erosion was most severe during the winter on fallow and recently seeded land, and appears to be on the increase at the present time. In general, cultivation has been extended to slopes as high as 10 per cent. and it is in these and associated areas that the damage has been most severe.

Wind erosion has occurred fairly extensively during the summers of 1934 to 1937.

The survey of the damage resulting from water erosion was made by means of transects through the property and a clinometer was used for the measurement of the slopes. From the transects, the location of gutters and fences, the occurrence of hills and eroded areas were determined, and measurements made of the slopes representative of the farm.

The information has been plotted on a map which is represented in Fig. 2. Of the total area of 801 acres, 195 acres were found to be rough limestone country and steep slopes suitable only for grazing purposes; some 58 acres of the arable land had been seriously damaged by water erosion of the sheet type and the remainder, 548 acres, was still in quite good condition for wheat farming except for the inconvenience of dissection by gutters which had developed since clearing.

From general observations it was estimated that about half of the surface soil had been lost from the areas mapped as badly eroded. Examination of profiles indicated that little surface soil had been lost from the remainder of the arable land, but continued cultivation had damaged the soil structure and reduced powers

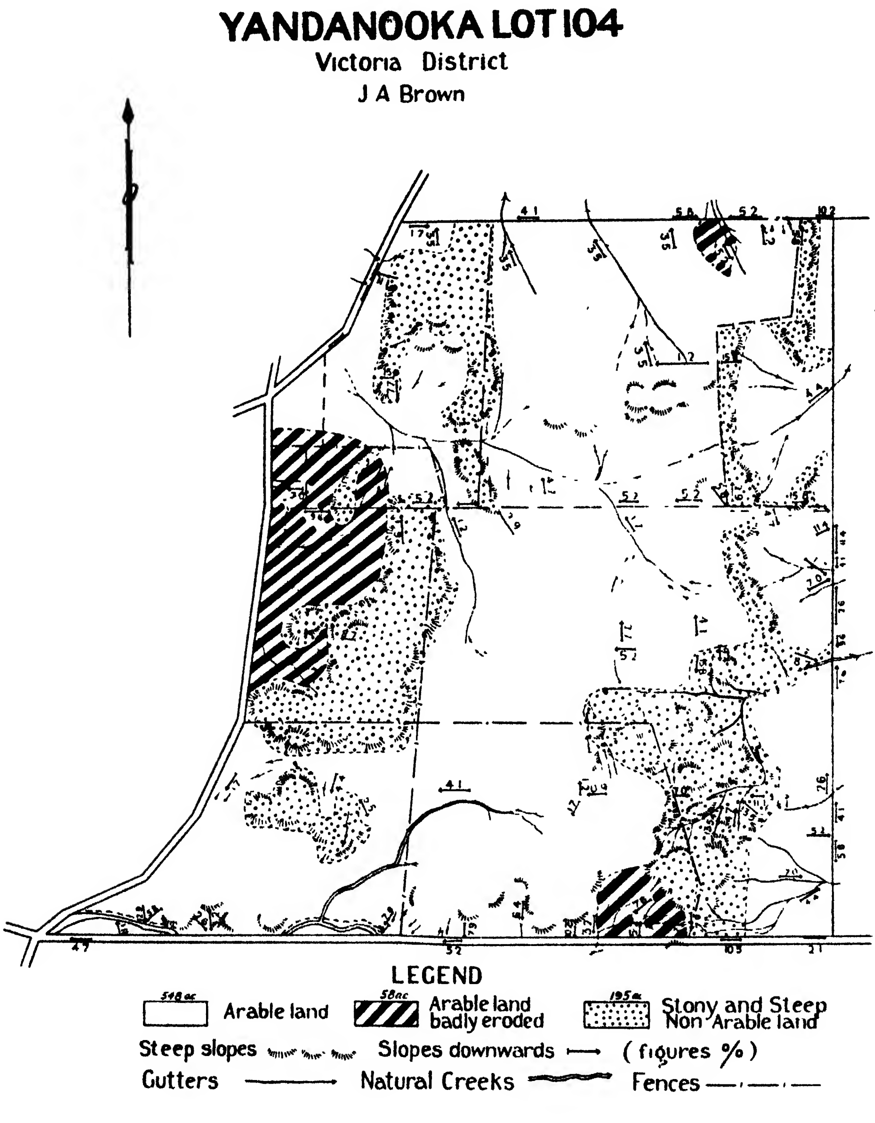


Fig. 2.—Sketch map of Yandanooka Lot 104 showing the disposition of rough limestone country and steep slopes and badly eroded arable land. Natural creeks, recently formed gutters, fences and slopes in per cent. fall are also shown.

of water absorption so that run-off was increased. Consequently, gutters had been cut in the lower portions of the undulations as the concentration of surface water moved into the main drainage channels.

FARMING EXPERIENCE.

Mr. Brown reports an average of about 20 bushels of wheat per acre over his cropped land until about the year 1933. During this early period of cropping yields of 25 bushels were obtained in the most favourable seasons. During the last five years, 1933-1937, the farm average has been only 14 bushels, with a maximum of 18 bushels. While such disabilities as rust and seasonal conditions may have contributed to this drop in wheat yield, Mr. Brown considers that it is probably largely due to the damage resulting from soil erosion.

Most likely the changes in the structure of the surface soil resulting from a heavy cropping programme are also contributory causes of reduced yields as well as increased run-off.

Prior to 1935, the property carried 500 sheep but, in later years, the flock has been reduced to 300. It is probable that the low rainfall of later years, as well as changed soil conditions, have interfered with normal pasture development and so necessitated the reduction in the number of sheep carried.

DISCUSSION.

Study of the information secured in the surveys shows that gullying appears to occur where cleared and cultivated slopes exceed 3 to 3½ per cent. and erosion, both of the gully and sheet types, is severe on cultivated land where the slope ranges from 6 to 10 per cent. Land steeper than 10 per cent. was not generally under cultivation.

Land deterioration has certainly occurred, due to a number of related causes including the exhaustive system of farm management adopted and heavy stocking, as well as to soil erosion. It is estimated that about 58 acres of otherwise valuable arable land has been seriously damaged by water erosion on this property. Probably more than 50 per cent. of the surface soil has been removed from these portions of the farm and, in addition, the paddocks, designed for the use of modern machinery, have been cut up into irregular pieces by deep gutters, the result of uncontrolled water movement. Not only are the farming operations interfered with, but the rush of waters from the eroding areas menaces the roads and necessitates the construction of expensive culverts to convey flood waters under the highways. Fig. 3 shows the large gutter cut on the south side of the main road as a result of flood waters from the eroded area in the south-eastern portion of Yandanooka Lot 104. It is to be observed that the soil is being eroded from the apron of the culvert and repairs are urgently needed if severe damage to the road formation is to be avoided in the future.

The acceleration of erosion by continued cultivation and the value of timber regeneration with the re-establishment of natural pastures is shown by a comparison of the situation on portion of the southern boundary of Yandanooka Lot 104 and the property adjoining on the south. Both areas were cleared about the year 1923 and water erosion became evident in 1927. Subsequently, cultivation was continued on this portion of Yandanooka Lot 104 but, on the other property, timber and herbage were allowed to regenerate naturally and cultivation was suspended. Figure 4 shows the condition on these portions of the two properties in 1938. Water erosion was almost completely arrested where regeneration was permitted, but increased rapidly under continued cultivation on Lot 104 (left). In consequence, in the south-eastern portion of Lot 104 are about 10 acres of badly eroded land which represents a loss to the farm and constitutes a menace to the

Fig. 3.—Large gutter formed by flood waters from the eroded area in the south-eastern portion of Yandanooka Lot 104. It is to be noted that the road formation is being menaced by the extension of the erosion in this gutter.

road. It is the wash from this area which has cut the large gutter shown in Fig. 3, and which may be seen through the fence in the timbered area in the right centre of Fig. 4.

It may be safely concluded that something over 10 per cent. of the arable area of this farm has been damaged by wafer erosion. This damage could have been largely avoided by the adoption of proper control measures in the first five years when the soil was practically in a virgin state and resistant to the forces of water erosion. If this arable land be valued at £5 per acre and the damage estimated at 50 per cent., the loss may be put down at £150. Had this sum been put into a five-year programme of erosion control at the outset, the problem would have been largely avoided and a permanent asset maintained, resulting in an annual increase of at least two or three bushels per acre of land cropped. The present situation is that the farm urgently needs a programme of contour bank construction which will now be much more costly on account of the damage already done. Furthermore, this action is the more urgently needed to arrest future increases in the damage done and to allow nature to repair the losses sustained.

The matter is not merely of interest to the individual farmer, but also the local governing bodies and to the State. The State suffers from land deterioration, road boards are faced with damage to road works, and the individual with loss of income and enhanced difficulties in farm management.

Action is being taken in this State by the Soil Conservation Committee, and the results of a State-wide questionnaire are now under consideration to assist, in some measure, evaluation of the situation in the agricultural areas. Similar enquir-

Fig. 4.—The natural regeneration of timber and herbage on the right has almost completely arrested water erosion. On the other hand, erosion has been accelerated by the continuance of cultivation on the portion of Yandanooka Lot 104 shown in the left portion of the picture.

ies are being undertaken in all States of the Commonwealth and it is hoped that the result will be concerted action by all parties interested to avoid the serious losses which have been reported from other countries.

ACKNOWLEDGMENTS.

Special acknowledgment is made of the assistance of Mr. J. A. Brown, of Yandanooka, in placing information at the disposal of the writer and in providing assistance in the carrying out of the work. The experience and advice of other farmers throughout the districts visited are very much appreciated, and thanks are tendered to Mr. N. Davenport for assistance in carrying out the survey and inspection.

THE VALUE OF SHEEP CLASSING AND MATING.

Hugh McCallum, Sheep and Wool Inspector.

The improvement that has taken place in the flocks of Western Australia of late years is the result of thorough and systematic sheep classing. Better flocks mean bigger returns, and every sheep owner is recommended to class the flock before shearing. The sheep are then carrying full evidence of their value as producers of wool.

Sheep classing means grading the animals that are similar to each other in quality, whether good or bad, into different flocks. In order to class a flock satisfactorily, it is essential that the farmer should examine each sheep individually. To be a thoroughly efficient classer, it is necessary for one to understand and be able to recognise the various qualities and types of wool.

If the flocks are not classed, the undesirable units will retard their improvement. The sheep will soon deteriorate and will grow very little good quality wool. Many farmers do not class their flocks and in consequence they do not receive the returns compared with the man who does class his flock.

The percentage of inferior sheep to be culled from the flock will depend upon the standard of excellence set in the flock. Having fixed a certain ideal to work on, the classer should have in his mind the perfect sheep, and reject any faulty sheep or those of a type other than the sheep the farmer wishes to breed.

Constitution is the foundation of a flock. Aim at breeding a sheep as big as is consistent with the natural conditions prevailing in the various districts of the State. The modern sheep of to-day are plain bodied, with a fair front and open face, broad, well-built animals showing plenty of bone, strong head, with neck of the correct proportion, thick and well set on the shoulders, straight back, ribs well sprung, chest wide, withers and rump well rounded and legs set well apart.

Classing does not only serve to get rid of the unprofitable sheep, but to prevent them from breeding and so perpetuate their weaknesses in the flock. By classing consistently every year the inferior sheep are culled and the source of many weaknesses in breeding is removed. Where the sheep are classed before shearing the farmer knows exactly what the faults are. Therefore, it pays to class and keep on classing yearly for perfection and type.

Only one aspect of this important work has been dealt with, that of discarding the inferior sheep and retaining only the better class sheep to reproduce themselves. There is, however, another reason for sheep classing. It is by this means that it is possible to exercise a certain control over future generations. This control is based on two well-known laws of nature, namely, the law of "like begets like" and the law of variation.

By the first-named law, it is known that within certain limitations the parent will beget progeny resembling themselves so that by classing ewes having certain faults as well as good points in common, the faults can be neutralised in their progeny by selecting rams that are exceptionally strong in those particular qualities in which the ewes are weak. In this manner the good points of both parents supplement each other in the offspring, producing a progeny better than the parents. Generally when the same characteristic is present in both parents it will be intensified in the progeny. This should be borne in mind at mating time, as it is in this manner possible to fix and accentuate a very undesirable characteristic.

There is also the law of variation where like produces unlike. Often both a high-class sire and ewe will produce a very inferior sheep; in fact, a freak. Improvement in sheep breeding by classing is a gradual process extending over

a considerable period, and it is only by following on the lines indicated that the farmer can hope to be successful and thus raise the standard of sheep breeding.

Many flocks have been ruined by introducing fresh strains or types quite unsuitable for the purpose. Grade ewes are very necessary. High-class sires could not reasonably be expected to give the best results from undesirable ewes in flocks that are not classed or culled yearly. Many breeders expect to remedy every defect in one generation. It is not possible to eliminate all the defects at the same time, because any given characteristic cannot be fixed in one generation. The value of flock improvement by careful selection and mating is dependent upon potency. The value of same can be determined by contrast of the improved and unimproved flocks.

The prepotency of individual sheep can be judged only from a knowledge of their progeny. Regarding mating, here you have the greatest problem to solve, and as every sheepbreeder is not gifted with that knowledge of what to mate and what not to mate, the following remarks may help to some extent.

To join extremes in any way only means breeding undesirable sheep, and if a medium between two extremes is necessary, it can only be obtained with safety by working up from one extreme and down from the other. Remember, there is no short way in sheep breeding; it is work that requires patience and constant study.

The object of the farmer should be to breed the best only and make adequate provision for reserves of feed. To feed the flock judiciously should be the first duty of every breeder; it means a greater measure of prosperity.

The production of quality wool is the paramount factor in sheep breeding. We breed some wonderful sheep that grow about as much wool as possible and of a quality that makes top price per pound and return per head, but many farmers breed sheep that are not worth feeding. Why? This is the result of a breeder not being watchful enough to realise that his sheep have gone back through using the wrong type of rams. The owner has not noticed the drift, for the reason that it has been gradual. How are they bred? It would be hard to state the reason, for they were never cared for or culled; just allowed to breed anyhow, year in and year out; inferior rams of many types were used. Therefore, in the purchase of rams it should always be remembered that the best is generally the cheapest and will, in the long run, make more actual profit than the cheaper animals.

THE NEED FOR UNIFORMITY IN WOOL.

As sheep exercise the dual function of wool and mutton producers, more attention should be given by farmers to both of these products. Even when prices are low, there is always a greater demand and higher price paid for quality wool. This type of wool costs no more to produce than inferior wool. The most essential points in the fleeces are uniformity of length, evenness in quality, and freedom from kemp hairs or coarse wool. The reputation of any flock depends on the appearance of the clips on the show floor. If the clip is uniform it can generally be taken as an accepted fact that careful management and selection are exercised, but when the contrary is the case it shows that the flock cannot be depended on to produce a uniform result to the grower. Therefore, quality wool cannot be grown on sheep of indiscriminate breeds.

Quality in wool means that the wool has all the characteristics required to give the highest spinning capacity possible for its degree of fineness. Having obtained length, density is next introduced, taking care all the time to maintain the length. This can only be done by selecting rams with length and density combined. Therefore, the rams used on the new generation should be better,

though they will perhaps be more expensive than those used on the original flock. Such progress should be continued every year and the remaining defects eliminated and that which is gained should be retained and, if possible, fixed until eventually the general standard is raised.

The benefits of judicious yearly classing may be summed up as follows:—It prevents inferior animals from breeding and raises the standard of the flock. It supplies the source of knowledge required for selecting the correct type of rams. It enables the breeder to ascertain whether the rams he has selected are giving good results. It enables the breeder to grow the correct type of wool. It enables the breeder to work towards a definite object. It makes wool classing easier and more satisfactory, and above all, the farm is made more productive.

In conclusion, I may state that with the ever-growing competition for wool from artificial fibres, it will be necessary for wool growers to produce the best and nothing but the best, and this can only be obtained by systematic selection and breeding. At present the name of Australia stands supreme throughout the world as a fine-wool producing country, and every Australian sheep breeder should make it his business to further this reputation by carefully classing his sheep.

THE FRUIT INDUSTRY IN WESTERN AUSTRALIA.

GEO. W. WICKENS,
Superintendent of Horticulture.

ACREAGE, PRODUCTION AND EXPORT.

From figures quoted in the returns given hereunder it will be noted that for the first time in many years the area under apple trees has failed to make an annual increase, the total acreage in 1936-37 being 13,031, and in 1937-38 (latest figures available) 12,933, a reduction of 98 acres. To find a similar occurrence it is necessary to go back to seasons 1923-24 and 1924-25, when there was a reduction of 155 acres, from 9,672 in the former season to 9,517 in the latter. In the twelve seasons following there was a regular annual increase, aggregating in season 1936-37 to 3,416 acres.

Though the reduction of 98 acres from season 1936-37 to season 1937-38 is comparatively small it gives rise to the surmise that perhaps apple growers in Western Australia are at last heeding the many warnings of over-production that have been voiced during recent years, and have eased up in their planting activities. It will be noted that the reduction quoted has occurred in the unproductive area, the productive area having increased by 252 acres and the unproductive decreased by 350 acres.

In season 1938-39 the crop produced created an all time record, both in total number of cases and in production per acre of bearing trees. Actual figures relating either to acreage or production will not be known until later in the year, but is is shown later in this article that the export figures *plus* local consumption, say, 450,000 cases, are convincing evidence of a yield in 1938-39 amounting to at least 1,811,295 cases, and it is a fair assumption that the bearing area has increased from 9,738 acres in 1937-38 to 10,000 acres in 1938-39, which means an average production throughout the State of 181 cases per acre, a figure that has never even been approached before, the nearest being in season 1928-29, with 148 cases per acre. Not all this bountiful yield can be credited to the favourable weather conditions, quite a lot being due to better and more scientific husbandry on the part of growers.

One interesting feature has come to light in the export figures, which shows how the varieties grown have changed in the last ten to fifteen years. Once "Jonathan" held pride of place, now "Granny Smith," which twenty years ago was only planted in a few orchards, heads the list.

The following table shows the acreage (productive and unproductive) and production of all kinds of fruit trees in Western Australia for season 1937-38, with figures for 1936-37 in parentheses:—

WESTERN AUSTRALIA.

ACREAGE AND PRODUCTION OF FRUIT IN WESTERN AUSTRALIA.

Season 1937-38 (with figures for 1936-37 in parentheses).

ORCHARDS.

Kind of Fruit	Area.			Production.
	Productive.	Unproductive	Total	
	acres.	acres.	acres.	
Oranges	2,582 (2,608)	471 (450)	3,053 (3,058)	304,852 bus. (302,235) bus.
Mandarins	132 (139)	36 (41)	168 (180)	14,429 .. (14,981) ..
Lemons	436 (426)	70 (73)	506 (499)	63,904 .. (63,685) ..
Other Citrus	21 (18)	27 (27)	48 (45)	2,264 .. (1,677) ..
Apples	9,738 (9,486)	3,195 (3,545)	12,933 (13,031)	930,678 .. (1,045,369) ..
Pears	854 (864)	175 (166)	1,029 (1,030)	93,922 .. (101,472) ..
Quinces	79 (85)	14 (15)	93 (100)	7,381 .. (8,620) ..
Apricots	593 (607)	90 (95)	683 (702)	61,388 .. (63,668) ..
Peaches	651 (643)	214 (221)	865 (864)	62,261 .. (67,373) ..
Nectarines	165 (161)	71 (64)	236 (225)	15,869 .. (17,175) ..
Plums	849 (862)	258 (274)	1,107 (1,136)	71,975 .. (86,593) ..
Bananas	141 (164)	104 (85)	245 (249)	26,504 . (30,151) ..
Cherries	30 (28)	25 (22)	55 (50)	26,296 lbs. (46,950) lbs.
Almonds	297 (283)	52 (74)	349 (357)	62,733 .. (71,805) ..
Figs	345 (338)	62 (60)	407 (398)	37,807 bus (39,375) bus
Strawberries	28 (33)		28 (33)	50,240 pun (51,468) pun
Passion Vines	68 (51)		68 (51)	8,128 bus. (5,804) bus
Pineapples	8 (10)	3 (5)	11 (15)	1,421 No (9,981) No
Other Fruit	53 (73)	34 (33)	87 (106)	.
Small Fruit	4 (12)		4 (12)	
Total	17,074 (16,891)	4,901 (5,250)	21,975 (22,141)	

VINEYARDS.

	Area.	Production.
	acres.	cwt.
Table Grapes	1,045 (1,038)	58,350 (58,393)
Wine Grapes	1,608 (1,613)	48,112 (42,564)
Drying Grapes	2,524 (2,474)	195,415 (195,920)
Not Bearing Vines	1,031 (980)	... ...
Totals	6,208 (6,105)	301,877 (296,877)

Wine made from 1937-38 *Season's Grape Crop*—

	gallons.
Beverage Wine Fortified	107,271 (86,627)
Beverage Wine Unfortified	201,678 (145,339)
Distillation Wine	79,129 (116,994)

Dried Fruit made from 1937-38 *Season's Grape Crop*—

	lbs.
Raisins	607,012 (721,675)
Sultanas	1,016,222 (861,829)
Currants	4,227,388 (4,226,821)

Figures relating to acreage and production of vineyards, season 1937-38, are also given in above table.

EXPORT.

Apples.

It was fortunate indeed for Western Australia that in this year of high production her overseas markets for apples were not restricted by quotas, and regrettable as were the misfortunes experienced by Eastern States orchardists owing to drought and bush fires, they proved the salvation of the Western State's apple growers. The total quantity of apples actually shipped overseas from 1st January, 1939, to 30th June, 1939, amounted to 1,289,537 cases, and in July an additional 43,145 cases were sent abroad; also to the end of June, 28,610 cases were sent to the Eastern States, making a grand total of 1,361,292 cases: greater by over 400,000 cases than the previous record in 1936; in fact, greater by 25,446 cases than the total quantity actually produced in any previous season.

The export season just ended is the first in which details of varieties of apples shipped have been recorded, and the information is both interesting and useful. It shows that out of 32 varieties sent to overseas markets seven are responsible for 95 per cent. of the total shipments, "Granny Smith" heading the list with 329,460 cases and "Scarlet" at the bottom with two. Quantities of each are as follow:—

	cases.
Granny Smith	329,460
Cleopatra	303,452
Dunns	216,274
Jonathans	191,590
Yates	107,364
Rokewood	50,121
Doherty	26,418
Rome Beauty	16,989
Statesman	11,611
Delicious	9,908
Democrat	8,785
Nickajack	7,780
Sturmer	3,865
King David	1,474
Ballarat	1,064
Cox's Orange Pippin	789
Stayman	554
Pioneer	508
Stone Pippin	468
Newtown Pippin	316
Ribston Pippin	302
White Winter Pearmain	203
Gravenstein	66
Shorland Queen	43
London Pippin	38
Strawberry Pippin	34
Granny Mac	22
King Cole	12
French Crab	9
Reinette du Canada	9
Pomme de Neige	7
Scarlet	2
Total	1,289,537

PEARS.

Pears also produced a record crop, with record shipments. Production figures are not yet available, but the quantity exported from 1st January to 30th June, 1939, amounted to 67,041 cases, the previous largest export total being in season 1932-33 when 46,986 cases were sent away. Twenty varieties are included in the list and it is a coincidence that, similar to apples, seven varieties made up 95 per cent. of the total. Details of the number of each are as follow:—

	cases.
Josephine	22,616
Winter Nelis	13,481
Beurre Bosc	8,367
Packham	8,253
Comice	8,112
Glou Morceau	3,031
Winter Cole	942
Keiffer	776
Winter Bartlett	529
Vicar	525
Beurre d'Anjou	202
Bartlett	50
La Conte	44
Howell	35
Duchess d'Angoulene	22
P. Barry	15
Garber	14
Madam Cole	13
Beurre Clairgeau	10
Broom Park	4
	67,041

GRAPES.

Grapes were responsible for another export record in 1938-39, the quantity of fresh grapes sent away amounting to 84,765 cases; the previous record being in season 1937-38 with 72,752 cases.

QUANTITIES AND KINDS OF FRUITS EXPORTED.

The following table shows quantities of each kind of fruit exported for year ended 30th June, 1939, and the destinations to which the fruit was shipped. In the period covered some fruit was exported during the first half, from 1st July to 31st December, 1938; in fact, nearly all the oranges were sent away in 1938.

Kinds of fruit and quantities in cases, July to December, 1938, were—

	cases.
Apples	11,758
Oranges	2,457
Grapes	5
Grape Fruit	48
Lemons	15
Tomatoes	10
Peaches	40
Plums	61

The total quantity of fruit exported for year ended 30th June, 1939, constitutes a record for the State—1,457,467 cases. The previous record was in 1936 with 1,010,920 cases.

EXPORT OF FRESH FRUIT FROM WESTERN AUSTRALIA TO OVERSEAS PORTS FOR YEAR ENDING 30TH JUNE, 1939.

Destination	Apples.	Pears.	Oranges.	Grapes.	Grape Fruit.	Lemons.	Tomatoes.	Peaches.	Plums.	Passion Fruit.	Melons.	Totals.
	cases.	cases	cases	cases	cases	cases.	cases	cases	cases	cases	cases.	cases.
London	510,366	49,456	2	11 525				1		17		571,367
Hull	23,082											23,082
Liverpool	146,613											146,613
Newcastle	13,201											13,201
Glasgow	154,117			502								154,619
Southampton	52,644			1,346								53,990
Hamburg	130,240	2,836		2,175								135,251
Stockholm	139,679	13,097		2 473								155,249
Rotterdam	20,457											20,457
Singapore	51,489	1,209	2,476	23,345	2	221	10	225¼	769½	2	26	79,775
Penang	3,802		143	2 272				1½	34			6,252½
Batavia	4,292	70	5	2,615					71			7,053
Belewan	1,796	5	4	311								2,116
Sourabaya	2,887	118		1 563				10½	48½			4,627
Bangkok	1 255			1 424								2,679
Samarang	2,126	40		1,333					10			3,509
Palembang	100			14								114
Saigon	337		25	620	1	1						984
Rangoon	511	15		3 137					22½			3,685½
Malta	1,264											1,264
Colombo	10,756	10	20	25,445	25			3	1			36,260
Port Said	23,113	85		2,248					28			25,474
Bombay	3,337			650								3,987
Aden	1 260		60									1,320
Mauritius	50			20								70
Calcutta	379	90	50	1,166	10							1,695
Madras	2,142	10	30	581	10							2,773
Totals	1,301,295	67,041	2,815	84 765	48	222	10	241¼	984½	19	26	1,457,467

IMPORTATION OF FRUIT TREES AND PLANTS

Apple and orange trees bulk largely in the number of fruit trees brought into Western Australia from the Eastern States, and, as a matter of fact, the great majority of trees planted are propagated in the East. Particulars showing numbers of all kinds of trees and plants are shown in the following table:—

PLANT DISEASES ACT, 1914.

Return of Fruit Trees and Plants inspected at the Ports of Fremantle and Albany for Year ended 30th June, 1939.

Kind of Trees.	Fremantle.	Albany.	Total.
	No.	No.	No.
Apple	28,640	8,486	37,126
Apricot	1,781	246	2,027
Almond	4,711	502	5,213
Cherry	884	179	1,063
Fig	64	22	86
Lemon	3,620	3	3,623
Loquat	471	4	475
Mulberry	386	6	392
Nectarine	1,522	310	1,832
Mandarin	1,306	...	1,306
Orange	17,530	3	17,533
Grape Fruit	2,928	2	2,930
Cumquat	130	..	130

PLANT DISEASES ACT, 1914—(*continued*).

Return of Fruit Trees and Plants Inspected, etc.—(continued).

Kind of Trees.	Fremantle.	Albany.	Total.
Peach	7,321	434	7,755
Persimmon	88	6	94
Pear	4,687	226	4,913
Plum	3,807	400	4,207
Quince	290	11	301
Banana suckers	3,500	...	3,500
Walnut	160	39	199
Chestnut	20	2	22
Other nut	555	8	563
Olive	19	6	25
Tung Oil	9,900	324	10,224
Guava	...	3	3
Currant	250	12	262
Gooseberry	329	28	357
Loganberry	173	12	185
Raspberry	195	12	207
Strawberry	10,838	...	10,838
Apple stocks	22,000	...	22,000
Peach stocks	10,510	...	10,510
Pear stocks	2,000	...	2,000
Palm seed	(bags) 3	...	(bags) 3
Ornamental	20,270	1,129	21,399
Bulbs and Roots	411,113	212	411,325
Totals	571,998 + 3 bags	12,627	584,625 + 3 bags

In the returns showing quantities of fresh fruit brought over from the Eastern States it will be noted that oranges, bananas, cherries and pineapples are most in evidence. Details are as under:—

IMPORTATION OF FRESH FRUIT INSPECTED UNDER THE PLANT DISEASES ACT, 1914, FOR YEAR ENDED 30TH JUNE, 1939.

Kalgoorlie—

Bananas	2,930 crates	
Pineapples	132 ,,	
Nuts	115 bags	
Oranges	6,634 cases	
Lemons	144 ,,	
Passion Fruit	16½ ,,	
Tomatoes	379 ,,	
Grape Fruit	25 ,,	
Coconuts	1 bag	
Persimmons	1 case	
Olives	1 ,,	
Peaches	279 cases	
Plums	188½ ,,	
Nectarines	88½ ,,	
Cherries	460 ,,	
Apricots	24½ ,,	
Gooseberries	10½ ,,	
Loquats	1½ ,,	
Mandarins	146 ,,	
Strawberries	5 ,,	
		11,582 packages

IMPORTATION OF FRESH FRUIT INSPECTED, ETC.—(*continued*).

Fremantle—		
Bananas ...	128 crates	
Pineapples ...	1,907 „	
Nuts ...	8,860 bags	
Oranges ...	243 cases	
Passion Fruit	10 „	
Grape Fruit	20 „	
Cherries ...	2,211½ „	
Gooseberries	151½ „	
		13,531 packages
Albany—		
Bananas ...	4 crates	
Pineapples ...	3 „	
Nuts ..	*nil*	
Oranges ...	63 cases	
Grape Fruit	3 „	
Coconuts ...	½ bag	
		73½ packages
Carnarvon—		
Nil ...	*nil*	*nil*
Total ...		25,186½ packages

The figures giving quantities and kinds of fruit imported from overseas show there is still room for more home grown bananas in the local markets, no less a quantity than 56,877 crates having been imported during the year ended 30th June, 1939. Details are as follow:—

IMPORTATION OF FRESH FRUIT UNDER THE QUARANTINE ACT FOR YEAR ENDED 30TH JUNE, 1939.

	lbs.
Bananas ...	4,550,206
Pineapples ..	377
Mangoes ...	770
Mangosteens ...	720
Grape Fruit ...	10,025
Coconuts ...	162,226
Nuts ...	65,769
Total ...	4,790,093

SPECIMENS FOR LABORATORY DIAGNOSIS OF DISEASES IN STOCK.

Laboratory facilities for the accurate diagnosis of disease in all classes of stock, including poultry, exist at the Veterinary Branch, Department of Agriculture, Perth, and while many avail themselves of this service, there are others who are apparently unaware of its existence. Moreover, of those who do forward specimens and samples, very few follow out the correct methods, and quite a number received are of little value. The Veterinary Pathologist is always desirous of receiving specimens associated with mortality or disease in stock. In this way much valuable information regarding the diseases actually present in the State can be arrived at and a report for the individual farmer provided.

Care must be exercised to select specimens which enable the Pathologist to be of real assistance and the value of a laboratory diagnosis is limited by the character of the specimen and its state of preservation on arrival. Contaminated or putrefied specimens are of little or no value for diagnosis. It is hoped that many more people will take the advantage of the service available and that these

notes will assist them to send suitable material in a satisfactory state for examination.

A covering letter should accompany all specimens forwarded; on occasions samples have been received without even the owner's name and address. The following particulars are required:—

i. Name and address.
ii. Date.
iii. Age, breed, sex of animal or animals affected.
iv. Number in affected group.
v. Number lost.
vi. Number sick.
vii. When disease commenced.
viii. Symptoms noticed.
ix. Any treatment adopted.
x. General information on feeding, state of pastures, management.

Generally the organs of value are the lungs, heart, liver, spleen (melt), kidney and intestines. If, however, the main changes were associated with say the bladder or tongue that should be forwarded. Organs should be immediately placed in a very clean jar and covered with a 4 per cent. solution of formalin. Intestines should be placed in a separate bottle to other organs. Placing of tissues in formalin, of course, renders them useless to examine for bacteria (germs) in cases of infectious disease. For this purpose a glass jar should be boiled, together with the lid, and on cooling, portion of the organ placed therein without allowing dirt or other extraneous matter to enter. Specimens should always be despatched to the laboratory as quickly as possible.

With sheep it is preferable when possible to bring an affected animal to the laboratory and, in the case of poultry, where such is reasonably easy, birds should always be forwarded unopened. With poultry too, it is more desirable to send a typically sick bird than a dead one. For chickens, six at least are preferred, when a disease outbreak occurs.

Parasites.

Worms, etc., should never be placed in commercial methylated spirit if this can be avoided; 70 per cent. alcohol is much better.

Examination of the droppings of animals and birds enables the Pathologist to give a report of the type of worm present and the severity of infestation. Droppings should be gathered freshly passed and placed in a tin. They too, should be sent immediately as they are of little value when quite dry.

Milk Samples.

Strict cleanliness is essential when collecting and forwarding milk. The bottle should be thoroughly clean, the first few jets of milk discarded and the bottle filled without any dust or dirt contaminating it. A pinch of boracic acid should be added for preservation.

Milk is examined for the presence of mastitis and tuberculosis of the udder.

Blood Samples.

These are necessary for examination for contagious abortion of cattle and those requiring a diagnosis of this disease are issued with a special circular on the method of collection and transport.

Specimens should be addressed, Veterinary Pathologist, Department of Agriculture, Perth, and, to comply with Commonwealth regulations, should be sent by registered post.

PULLORUM DISEASE OF CHICKENS.

L. W. MAHAFFEY, Assistant Veterinary Pathologist.

Pullorum disease, which is prevalent in most countries of the world, is mainly a disease of very young chickens, few cases of fatal infections having been recorded in adult birds. However, the first indication of the presence of this disease in Western Australia was provided in 1935 when nearly 400 birds aged 10 to 12 months died from an infection subsequently diagnosed as Pullorum disease. Remarkably enough, no outbreaks of Pullorum disease in this State have previously been described in chickens. This is considered due to the lack of opportunity on the part of the Veterinary Pathologist, in the past, to examine chickens, rather than to the non-existence of the disease. The causative bacterium has been known here definitely since 1935, at least, and probably has been present much longer. The first outbreak in chickens to be definitely diagnosed occurred this year; on one farm over 3,000 died.

Cause.

Pullorum disease, formerly known as bacillary white diarrhoea, is caused by a specific germ known to bacteriologists as *Salmonella pullorum*. It attacks *very* young chickens of any breed or sex, although the mortality rate is higher amongst the heavy breeds, in which over 90 per cent. may die. In any breed, however, very high mortality is to be expected when the disease makes its appearance.

Symptoms.

Symptoms are observed very early in life and deaths may commence on the second day but rarely later than the fifth day after hatching. Consequently, when chickens commence to die in considerable numbers, within the the first week after hatching, the farmer may always suspect Pullorum disease. Faulty brooding methods and management may also cause substantial losses and a ready differentiation of the two conditions can be made only in the laboratory at the Veterinary Branch, Department of Agriculture, Perth. Chickens may, in some cases, be just found dead under the brooder. Others separate themselves from their fellows, appear very dull and listless with drooping wings, and do not feed or drink. In a number of cases a white diarrhoea is noticed which frequently pastes up the vent and interferes with the subsequent passages of the droppings. Not all infected chickens die. Those that manage to survive an outbreak for three or four weeks usually grow up apparently healthy but they very frequently become "carriers" and as well as being very poor layers, these constitute a constant menace in the future.

Post Mortem Appearance.

On opening a chicken which has died of Pullorum disease, in many instances, nothing abnormal may be seen. In some, however, any combination of the following abnormalities will be revealed:—

(a) Dark spots in the lungs, which are normally a pale pink colour; yellowish nodules may also be present.

(b) Enlarged liver with or without small pin point nodules visible on its exterior.

(c) Sometimes yellowish nodules on the heart.

Cure.

There is no known cure for the condition. The germ is present in all organs and tissues of the body.

Perpetuation of the Disease.

The chicken which becomes infected but does not die is the danger. It reaches adult age and commences egg production. In the adult carrier the germ remains localised in the ovary and is present in the egg when laid. Such birds are always poor layers and many, but not all of their eggs are infertile. If a fertile egg is incubated with a batch of healthy eggs the danger of the latter becoming infected after hatching is very real. A chicken hatching from an infected egg spreads the germ in the incubator and thus infects many of its fellows before being placed in the brooder. In the brooder, sick chicks pass the germs in the dropping, contaminate the ground and surroundings and provide the means for further infection of those which were possibly free of the disease on leaving the incubator. Only a few infected eggs amongst a thousand or two in an incubator are necessary to cause an outbreak of Pullorum disease.

Control.

First an accurate diagnosis is essential. Therefore, whenever an outbreak of disease or mortality occurs amongst chickens, farmers should communicate with the Veterinary Branch, Department of Agriculture, Perth, and forward or bring six chicks to the laboratory. For preference some at least should be alive and showing typical symptoms.

Since the adult "carrier" birds constitute the source of danger, steps should be taken to eliminate these. This may be done by a blood test of all birds on the property, when those shown to be carriers are separated and disposed of for table purposes as quickly as possible. The Veterinary Branch arranges for the testing if necessary. If mortality amongst chicks has reached 90 per cent. it is better to kill all survivors after a diagnosis is established rather than to allow them to grow up, since they are a constant source of worry then. In all cases runs which have been occupied by infected chicks should be dug over and thoroughly disinfected with lime, and fittings should be sprayed with 5 per cent. Izal or other similar disinfectant. The adult stock shown negative by the test are placed in a clean run separated from the positives, which are to be disposed of and yards previously occupied ploughed or dug over and disinfected.

Incubators should be fumigated before use with formaldehyde gas which is quite efficient and simply produced from the action of formalin on Condy's crystals. Three times during incubation the same procedure should be adopted and this is quite harmless to the developing eggs. The method will be explained to anyone on application.

Conclusion.

It must be emphasised that Pullorum disease is a very destructive and serious disease and anyone having any cause to suspect its presence should immediately communicate with the Department's Veterinary Branch or send chickens to the Veterinary Pathologist. In addition there are other diseases of poultry which may take a heavy toll and it is hoped that farmers will take advantage of the service available to them at the laboratory, Perth, and forward diseased poultry to the Veterinary Pathologist, Department of Agriculture, for examination, which will enable an accurate diagnosis to be made.

GIANT STAR GRASS.

C. A. GARDNER, Government Botanist.

An expedition sent last year by the Government of the Union of South Africa to East and Central Africa for the purpose of collecting grasses which might prove of value in South Africa, returned with specimens of a remarkable species of *Cynodon* which they encountered in various parts of Tanganyika, Kenya, Uganda, and the eastern parts of the Belgian Congo. This grass, which apparently includes more than one strain of *Cynodon plectostachyum* (K. Schum.) Pilger, is claimed to be a remarkable species because of its astonishing rapidity of growth, its valuable forage properties, and its value as a soil binder in soil erosion. The grass, originally described as a *Leptochloa* by Schum in 1895 was known to be indigenous in Central and Eastern Africa, and is therefore not new to science.

There have been several reports in the Press recently in connection with this grass, but in the absence of its systematic identity it has not been possible to make any statements as to its value in this country. The genus Cynodon comprises several species indigenous in Africa, India and Australia, the most common species being *Cynodon dactylon* (Linn.) Pers., the "Couch grass" of our lawns and pastures, and the "Bermuda grass" of America, where it has long been introduced. Unlike the Couch grass, this newly rediscovered grass attains a height of from three to four feet, and spreads to an unusual width.

Writing in "Nature" (July, 1939), Dr. Pole Evans says: "Apart from its luscious and dense stand, often three to four feet in height, the most remarkable character of the plant in the veld was its amazing network of robust runners (stolons), and it was at once realised that in this plant Nature has provided us with valuable material for erosion control. Living material was brought to Pretoria and was planted out under conditions where the growth of the plant could be studied in detail. The plants have been under observation for some five and a half months, and during this period, under a rainfall of 27.49 inches they have made remarkable growth . . . Individual plants during this time have covered more than eight thousand square feet of soil, and in many instances have put out runners (with offshoots) from the parent plant, measuring in length more than fifty feet! These runners and offshoots, of course, anchor themselves down firmly at almost every node. The material offers great possibilities for erosion control in areas where this grass can be successfully established."

It will be noted that the habitat of the plant is tropical Africa, and that experiments are in progress in Pretoria, where there are indications of success. Pretoria lies in Lat. 35deg. 47 minutes south, *i.e.*, slightly further south than Carnarvon. The rainfall there is about 27 inches, which falls almost entirely in the summer (October to April) the winter rainfall (May to September) averaging slightly less than two inches. The extreme temperatures are much the same as those of South Western Australia, the winter and summer mean temperatures about 80 degrees and 70 degrees respectively. The seasonal incidence of the rainfall is, however, quite reversed. It is evident that this grass, like so many other warm climate grasses, makes its active growth during the summer, and for this reason it is scarcely to be expected that it will be suited to the conditions in South Western Australia. On the other hand, there is every possibility that the grass might prove eminently successful in the north of Western Australia, especially in the alluvial plains of Kimberley and the De Grey River. Efforts will be made to secure both runners and seeds early in the coming year, when they should be available for distribution, and establishment made in suitable localities. Except under conditions of a high water table, or of irrigation, there seems to be little or no future for the species below the latitude of Carnarvon.

FRUIT JUICES AND RELATED PRODUCTS.

By V. L. S. CHARLEY, and T. H. J. HARRISON.

(Technical Communication 11 of the Imperial Bureau of Horticulture and Plantation Crops, East Malling, Kent, England, 1939, pp. 104, figures 49, bibl. 118, 5s.)

Whether we have suddenly developed sense, or whether the old slogan "an apple a day keeps the doctor away" has at last struck home, is immaterial. The fact remains that we do eat more fruit and that more fruit is being produced. Market quality standards have become higher and growers are now faced with the problem of how to dispose satisfactorily of fruit which does not come up to the accepted standards of size or colour, though otherwise perfectly good. Among processes offering a solution, that of unfermented juice production has long commended itself to fruit producers in Europe and the U.S.A.

Hitherto, though short articles on different aspects of processing have been available since 1914 in the annual reports of the Long Ashton Research Station, lack of precise information on the exact technique employed has checked progress in England.

It has remained for Charley to give under one cover a complete detailed account of the manufacture of apple juice based on his knowledge of the latest foreign methods and on his own continued investigations at Long Ashton.

In the present bulletin he deals with the manufacturing process in detail starting with the selection of the fruit and taking us through every stage in turn up to the disposal of the final product in bottle, can or other type of dispenser. He does not confine his remarks to any one process but gives particulars of different methods found satisfactory and discusses their merits.

Further he deals more briefly with such other fruit products as grape, citrus and soft fruit juices, cider, fruit wines, etc., with the concentration of fruit juices by hot processing, by freezing and by spray drying, and with the disposal of pomace.

He describes methods of analysing juice for the determination of specific gravity, total acidity, tannin, alcohol and sulphur dioxide.

Finally he discusses the suitability of particular metals and alloys for the construction of the requisite apparatus, the clear illustrations of which add greatly to the usefulness of the publication.

But the problems of juice production do not, unfortunately, begin and end with its manufacture, and the economic and nutritional aspects are equally important. We are, therefore, grateful to Harrison for his concise and adequate treatment of them in the first twenty pages.

He shows that a permanent fruit juice industry on a large scale can only be developed where large supplies of raw material are available each year at a reasonable price. The cost of manufacture is not small, and if sales are to grow it is essential that retail prices should be reasonably low so as to compete with other drinks. This means that distribution costs must be low and that the industry must depend essentially on its home market. Here regulations are necessary to protect it from competition with synthetic products.

The nutritive and therapeutic qualities of fruit juices are discussed at sufficient length to show their great value, not only to children and invalids and for the treatment of gastric troubles, but also in the diet of the normal healthy adult.

A short glossary is included for the use of the less expert, and this together with the comprehensive index should make the information readily accessible to all.

"APPLE TREE PRUNING."

(WITH A MINIMUM OF INJURY TO THE TREE.)

GEO. W. WICKENS, Superintendent of Horticulture.

I have chosen the above as a heading to this article because I wish at the commencement to stress the fact that neither in winter nor summer can apple trees be pruned as pruning is practised in Western Australia without injuring the trees to a greater or lesser extent, the amount of injury done being governed by the violence of the operation.

Fortunately, so far as summer pruning is concerned, there are not many growers who still adopt that method in endeavouring to induce or increase fruit-bearing habits, the intelligent use of lateral growths having superseded for this purpose the summer pruning which many years ago was quite common: and summer pruning in the great majority of orchards is now limited to removing sufficient young shoots on varieties such as "Yates" and "Dougherty" to allow the sun's rays to reach and colour the fruit. On strongly growing trees with heavy foliage this amount of summer pruning is necessary and cannot be avoided, but even here what I have said above about injuring the tree holds good, though the damage done is so slight as to be practically negligible.

It is in ordinary orthodox winter pruning, however, where hard cutting, particularly of young trees, is believed to give strength, that very real damage to the trees is being caused, and although I have not enough facts before me to state definitely that hard winter pruning is one of the main contributing causes to the condition in apple trees known as "die-back," I firmly believe such to be the case. For the past ten years I have been closely watching the growth of apple trees which have had winter pruning limited to removal of excess shoots before these have grown into limbs, and the usual ordinary treatment of fruit-bearing laterals; the extra vigour of trees so handled compared with those pruned in the ordinary manner is outstanding. I would like here to state, for the information of the many apple growers in Western Australia who have attended pruning demonstrations given by myself that during the many years I have been attached to the Department of Agriculture—starting with the first pruning demonstration at a small orchard in the Upper Blackwood in 1903—I have changed by degrees from a fairly hard pruner with a liking for fruit borne on short spurs, to one who would endeavour to train the tree from the time of planting in such a way that all hard cutting would be eliminated. Those who have followed my demonstrations will know that at first "Jonathan" was the only variety upon which I used laterals for carrying the fruit, all the rest I spur pruned, but eventually I reached the stage when all varieties were treated as lateral bearers, and I believe I was the first in Western Australia to give demonstrations showing that the best results could be obtained with "Yates" when these were made to produce their fruit on laterals instead of spurs, this latter variety having been looked upon as essentially "spur-bearing."

As stated above I have been closely watching trees very lightly pruned and judging results since 1929, and though I was convinced five years ago that our pruning system required changing I had not sufficient tangible results to put before growers as proof, until one of these trees—the only one I had handled from time of planting—had cropped for several years. Last year I considered the test sufficient, and I broadcast on 6th May, 1938, particulars of the new system, and advised growers to try it. I have been flattered by the number of growers who have followed that advice in the winter pruning seasons of 1938 and 1939, and whereas previously there were only a few trees from which to make comparisons,

now there are literally thousands, and while the system advocated can only attain its best when done from the time the tree is planted, it can be applied at any stage to a tree that is making vigorous growth.

What first caused me to think that pruning the leading shoots of an apple tree had an injurious effect on their growth was noting that stronger and better growths were made by any shoots that had been, either by accident or design, left unpruned.

The commonest occurrence, and one that all pruners must have noticed, is the effect of leaving unpruned the growth arising from the second bud from the top of the leader, and pruning the shoot arising from the top bud: in practically every instance the growth from the lower bud will far exceed that from the top bud, and, to quote a very common saying amongst pruners—"it has robbed the leader." Reverse the position by pruning the lower shoot allowing the top one to remain unpruned, and the top shoot will show the greater growth. Right through the tree this principle holds good; the unpruned shoot—other things being equal—exceeding the growth of the pruned shoot. I am giving the above as one instance that I had noted, but there were many, very many, others, and they occurred not only on apple trees, but on pear and stone fruit trees as well. To mention them would make this article unduly long, so I will only say to growers who are interested, and who want proof—"Go ye out into your orchards, seek, and ye shall find."

"The System."

Commence at the time the tree is planted, and if when it is received from the nursery it has three or four nicely spaced limbs of equal growth, allow these limbs to remain unpruned, but in early September put a shallow nick through the bark above one or two buds where limbs are required for leaders. Varieties like "Yates" and "Granny Smith" without nicking usually throw out a sufficient number to allow a choice of the best to be made, but varieties like "Cleopatra" and "Dunns" instead of making side shoots often turn to fruit buds, and to make certain of growths for leaders it is best to nick above the buds where the limbs are required. If the young trees, when received from the nursery, have three or four limbs which are not of equal growth, but have one strong and two or three weak, or two strong and one weak, or two strong and two weak, or any other combination, cut the strong ones back to a length of four to five buds from the base and let the weak ones remain unpruned. If the root system is evenly distributed around the base of the tree (not one-sided) it will be found in practically every instance that the growths made, from the unpruned weak limbs will be so much stronger than the growths made from the strong pruned limbs that the tops when the season's growth is finished will be nearly level, and not only that, but the previously weak limbs will be stronger than the previously strong ones.

Figure 1 illustrates a "Yates" apple tree: a weak tree (a whip) at time of planting in July, 1937. It was cut back and threw out one strong limb and three weak ones. The strong one was pruned to about four buds from the base—see white mark on limb near fork—and the other three were left unpruned. The figure shows that the growths from terminals (see narrow white mark) of the three weak limbs have not only equalled in length the growth from the strong limb, but are now stouter and stronger right down to the fork than the pruned limb. The orchard where this photograph was taken comprises nine acres of young trees, and in every instance where there were strong and weak limbs on any tree the strong were pruned and the weak left unpruned and in every case the result was similar to that described.

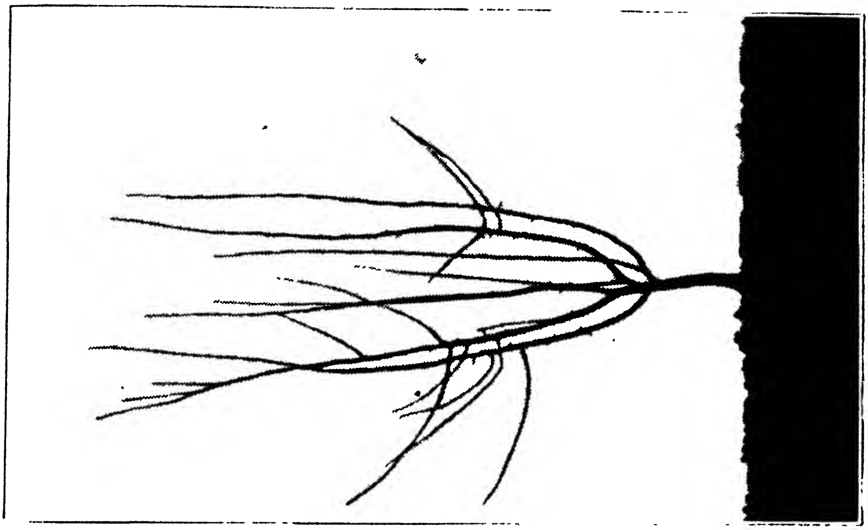


Fig. 2

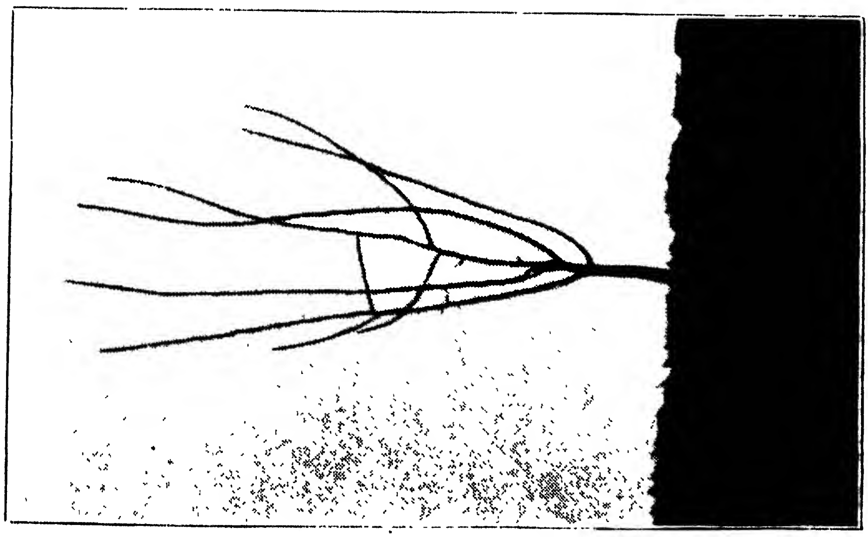


Fig. 1

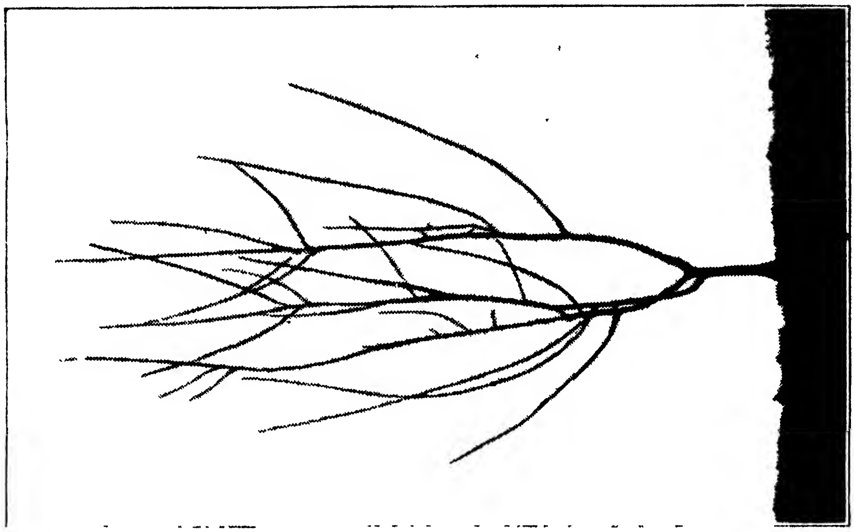


Fig. 4

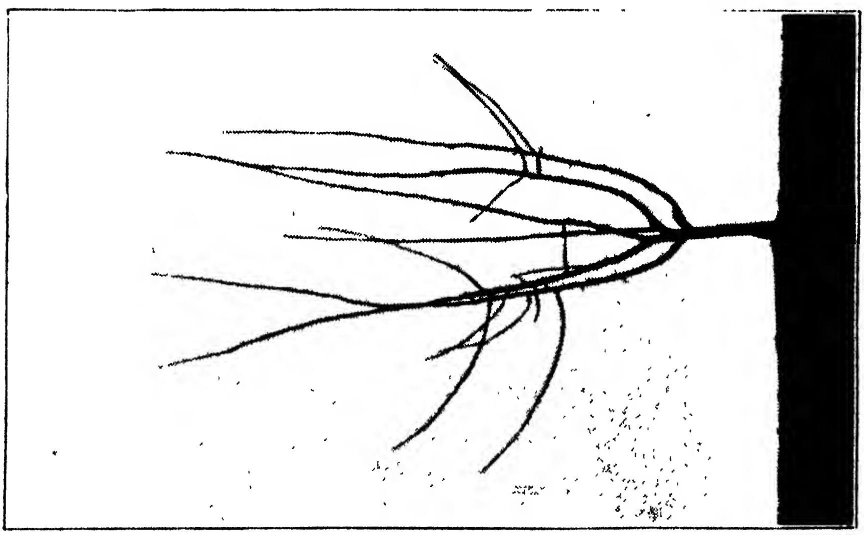


Fig. 3

Figure 2 illustrates a "Yates" apple tree, planted July, 1937, pruned at planting, and only one limb pruned in 1938.

Figure 3 is the same tree pruned this season in accordance with the new system. It will be noted that apart from removing the side shoots from the top of one leader on the left (an essential factor in the system), and one shoot at the bottom that was growing straight up through the tree, hardly any cutting has been done. The tree is so well shaped that very little propping out is required, one spreader between two limbs being all that is necessary.

I would like here to draw attention to the limbs growing out from the main limbs. These will not be pruned, and will be used as subsidiary leaders to assist in forming the main framework of the tree. Another fact worth mentioning is that limbs coming out at the angle shown, and not situated at nearly one level, like leaders arising from the end buds of a pruned shoot, are much the stronger and better placed.

Figure 4 is a photograph of a "Granny Smith" apple tree with two seasons' growth, planted in 1937, pruned at time of planting and unpruned in 1938.

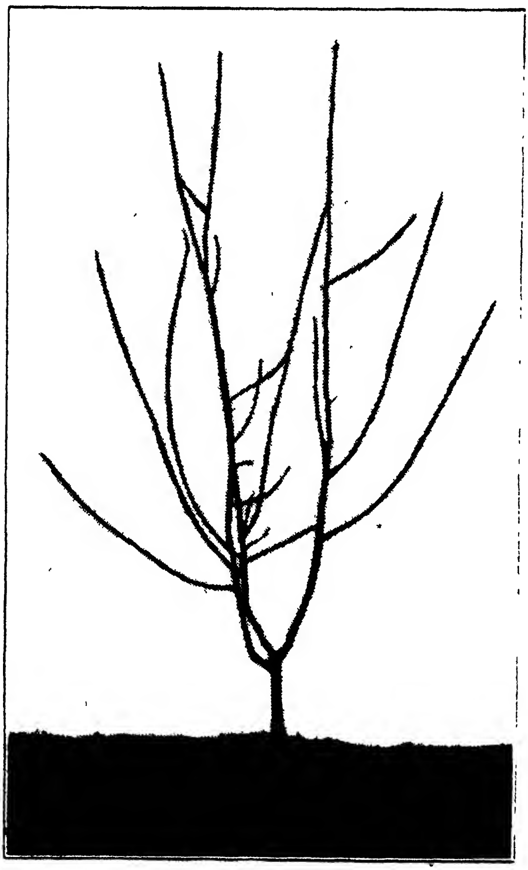


Fig. 5

Figure 5 is the same tree as shown in No. 4 pruned in August this year—a well shaped tree, strong and vigorous, required very little pruning, excepting removal of side growths near tops of leaders.

Though I have only used "Yates" and "Granny Smith" as illustrations there are "Jonathans," "Cleopatras" and "Delicious" treated in the same way in the same orchard, all quite successfully. In connection with "Jonathans" I thought at first it was one variety to which the new system could not be applied on account of its weak and rather bushy habit of growth, and its propensity to crop on the previous year's growth, whether lateral or unpruned leader, but experience has shown the advantage in growth is such that the extra time entailed in stripping blossoms or young fruits from the terminals of the unpruned leaders is well repaid by the extra vigour imparted to the tree.

It must be remembered that during the first three years, no matter what variety of apple tree is under consideration, fruit must not be allowed to grow on or near the ends of the leaders, and to prevent this either the blossoms or young fruits must be removed. If allowed to remain the weight of fruit will bend the leaders out of shape.

When training young trees having an upright habit of growth, such as "Cleopatra" and "Granny Smith" it is essential that either by propping or using spreaders between limbs on opposite sides of the trees, the trees are opened sufficiently in the centre to allow light and air to circulate freely and room between the limbs for fruit bearing laterals. Care must be exercised when spreading the trees in this fashion to avoid placing any limb at such a wide angle that the inside buds will grow upwards to the detriment of growths from the terminals and from the buds on the outside of the leaders—these latter growths, as pointed out earlier in this article, form the sub-leaders. Trees treated in the manner advocated, if healthy, will commence bearing in their fourth year, and from then onwards pruning is simple, merely comprising the removal of side growths from the leading shoots, always keeping the topmost growths unpruned, the removal of excess growths before they obtain sufficient size to require being cut out as limbs later in the tree's life, and treatment of laterals as the main source of fruit production.

A bit of advice about laterals might be of service here and it is this—use every endeavour to provide laterals that as nearly as possible spring direct horizontally from the larger growths whether leaders or sub-leaders: a lateral that has been heavily pruned as a spur for several years before being allowed to remain with an unpruned terminal, is in the same injured condition from over-pruning as the annually pruned leader. When lateral growths have reached a length greater than they can support, or bring to size, the fruit borne on them, then shorten them back to a suitable length.

Figure 6 is a photograph, taken in August this year, of a "Granny Smith" apple tree in Mr. George Parke's orchard at Donnybrook, which in 1930 he very kindly handed over to me for the purpose of testing my theories about unpruned terminals. The tree is one of 400 whips planted in 1930, and it is mainly due to the knowledge I have gained with this tree during the last ten years that I now can confidently describe the system as a success. It will be noticed a prop was needed last year to help support the crop, and there are growers who state that any system of pruning which does not make the tree rigid enough to carry its crop without other support to the limbs, is not worth considering: but a tree that bears as this tree has borne is worth propping, and even in orchards trained in the orthodox manner it is rare to see one where supports are not needed in seasons of heavy crops. This tree was supported by a prop in the centre, maypole fashion, and the small black objects showing amongst the limbs are pieces of leather attached

to the wires which extended from the pole to the heavily laden limbs before the crop was gathered, the leather being used to prevent the wires from cutting into the limbs.

Fig. 6

The history of the tree's production is as follows:—

Planted 1930.

In 1934 produced 1 case.

In 1935 produced $4\frac{1}{2}$ cases.

In 1936 produced 8 cases.

In 1937 produced 8 cases.

In 1938 produced 10 cases.

In 1939 produced 10 cases.

A fine record truly!

Figure 7 is a "Granny Smith" in an adjoining row, one of the 400 planted at the same time, and is a fair average specimen of the trees which have received exactly the same treatment in every respect—fertilising, cultivation, etc.—as the

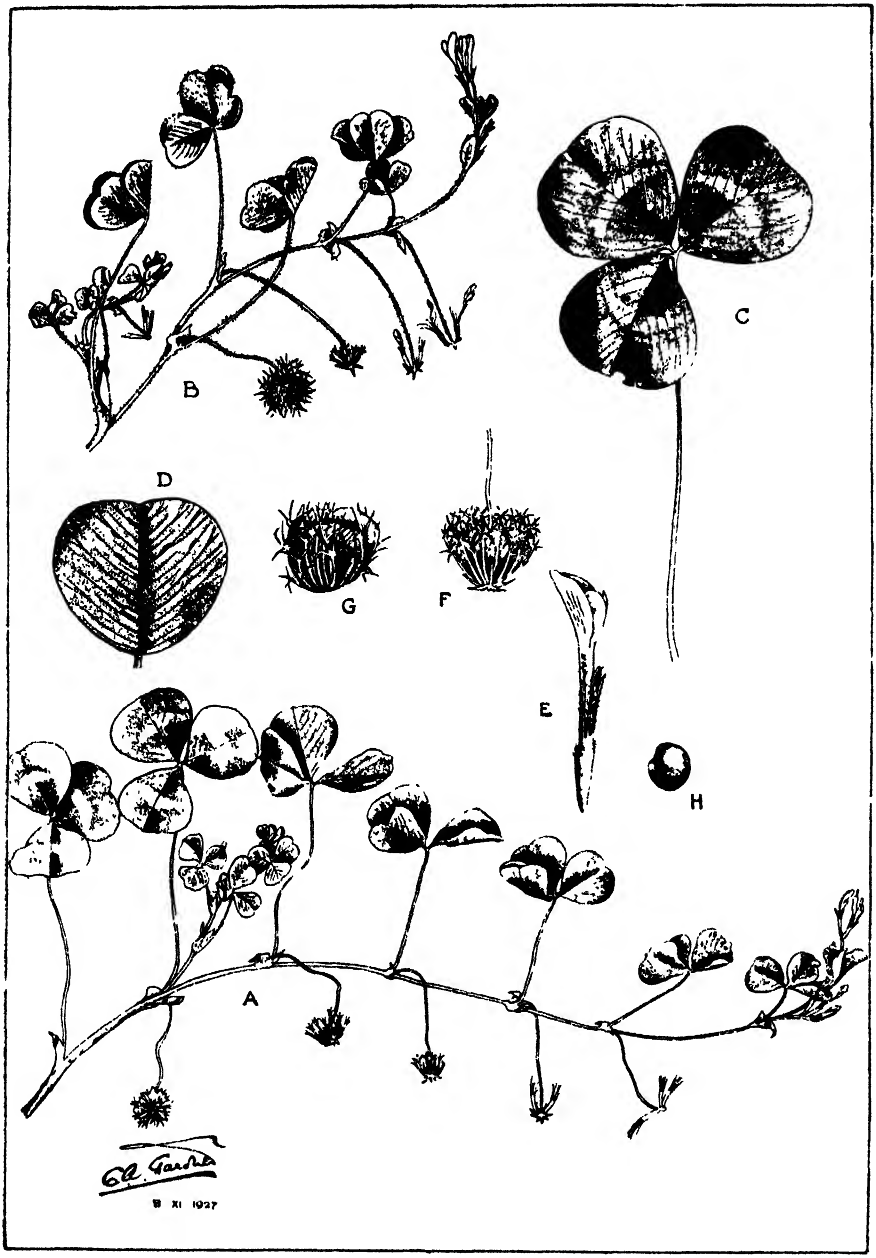
Fig. 7

experimental tree, the only difference being pruning. The experimental tree commenced bearing in earnest in 1935, the remainder waited until 1938, and then only produced an average of 1½ cases per tree.

SUBTERRANEAN CLOVER SEED.

G. R. W. MEADLY.

The production of subterranean clover seed is a comparatively recent development, for the first serious efforts to harvest the seed were made in South Australia in 1900. At first, the production rate did not increase very rapidly. Statistics show that in South Australia only five cwts. of seed were harvested from ten acres in 1916-17 with a marked advance in 1923-24, when 807 cwts. were secured from 405 acres. In the 1929-30 season, the output had reached 250 tons which probably represents the present annual average production, although this naturally depends on seasonal conditions and also, to an appreciable extent, on the demand for seed.



SUBTERRANEAN CLOVER.

(*Trifolium subterraneum*, *L.*)

A. and B.—Portion of plant showing habit and development.
C.—Leaf showing whitish crescent-shaped markings
D.—Leaflet with brown flecking (on veins near midrib).
E.—Flower.
F.—Maturing seed head.
G.—Ripe burr with three pods.
H.—Seed.

About the same time that seed production commenced in South Australia, the first sowings of subterranean clover were being made in this State. A number of years passed before the real value of this clover was realised, but with the increasing use of superphosphates its importance was accentuated and growers became interested in the production of seed locally.

At first the methods used were crude, the burr being raked into heaps and sold without any further treatment. The more progressive farmers soon realised, however, that this method was not satisfactory, as it provided an excellent means of spreading both serious weed and insect pests. The actual crop likely to be secured from the burr was also difficult to assess. The early producers overcame many difficulties by ingenious inventions and at the present time Western Australia, besides providing its own seed requirements, supplies large quantities to the Eastern States and New Zealand markets.

STRAINS.

With a crop which is grown so extensively and under various conditions, differences in the nature of individual plants must be expected and many different strains have been noted. Some of these have been little, if at all superior, in any quality to the strain in general use, while others have been found to possess distinct advantages. The most important variant commercialised in this State is the early (Dwalganup) strain. Plants of this strain will flower considerably earlier than those of the mid-season (Mt. Barker) type and consequently seed formation commences earlier in the season.

In Western Australia one of our main difficulties is to grow a suitable leguminous crop in areas where the rainfall is not only low, but falls during a comparatively short period during the winter months. To be effective a crop must seed itself down each year, that is, not require re-sowing each season. This necessitates growing a plant which matures its seed while sufficient moisture remains in the soil. The early strain, depending on locality and season, commences flowering about the second week in August, while the mid-season strain commences about mid-September in the earlier districts and mid to late October in the later southern areas.

Bearing in mind this difference between the normal flowering periods, it is not difficult to realise the fact that the early strain is grown successfully in areas having a rainfall of 16 inches, or sometimes even less, while, to secure the best results, the mid-season strain requires at least 25 inches per annum. The advantages are not entirely with the early strain, however, for during the first season in particular it produces less leafage, and is not as suitable as the mid-season strain for the better rainfall areas. The two strains, therefore, are not at variance but supplementary to one another and one sown where the other should be grown will mean decreased returns, or possibly complete failure of the crop after the first year. Much mid-season seed has been wasted in the drier districts in the past and these early efforts have done much to discourage the growing of subterranean clover in those parts, although the early strain may be well suited to the conditions.

STRAIN CERTIFICATION.

The knowledge concerning the correct strain does not overcome the difficulty entirely, however, as the seeds of the two strains under discussion are so much alike that they cannot be definitely separated by examination. This difficulty has been eliminated by a seed certification scheme instigated by the Department of Agriculture in 1934. The essential features of this scheme are—firstly, the inspection of pastures during the growing period in order to ascertain whether the stand is sufficiently pure to warrant registering for the production of certified seed. At

this stage, the strains can be detected and the suitable areas are mapped. The next provision is the appointment of an Inspector to the producer's property for the entire period during which gathering, cleaning and grading are carried out. The duties of the Inspector are to check the areas from which the burr is secured, test the actual pure seeds content of the final seed, provide the necessary slips and tags, seal the bags and forward a representative sample from each bag to this office for checking purposes and testing for germination. Two grades are recognised, viz., not less than 98 per cent. and not less than 96 per cent. pure seeds. Each bears a distinctive tag and a slip is placed inside the bag. Information concerning the germination may be secured by referring the certificate number recorded on the tag and slip to the Department of Agriculture, Perth.

Certification tag for the early strain.

DEPARTMENT OF AGRICULTURE,
Western Australia.

CERTIFIED EARLY STRAIN (DWALGANUP)
SUBTERRANEAN CLOVER SEED.

Grown on Registered Area No. ....

The Germination Certificate concerning this seed is numbered.

Date.................... *This sack was sealed by*................................

[See over.] ***Inspector.***

(*Front*)

This Certification gives warranty as to Strain and Purity. Details as to Germination are obtainable from the Dept. of Agriculture, Perth, on quoting the Certificate number.

The purity is not less than 98 per cent.

(*Back*)

Facilities are available for the certification of both the mid-season and early strains, thus providing a guarantee concerning strain and pure seeds content, and also a reference by which the germination of the line may be secured.

The scheme protects the purchasing farmer, at the same time assisting the grower and seed merchant. The term "certification" is immediately associated with quality, and this serves to advertise as well as standardise the commodity.

Seed certification is by no means a local innovation but is closely associated with the industry in all parts of the world. The extra cost of sowing certified subterranean clover seed is less than one shilling per acre, a very small amount when compared with the difference which may result in the crop due to securing a wrongly named strain or a mixture of which only a small proportion is satisfactory.

Farmers are strongly urged to be "strain minded" and insist on certified seed bearing the Government seal and tag. The slight extra cost may well be regarded as cheap insurance against inferior lines.

PURE SEEDS CONTENT.

The Department has also provided facilities for the testing and sealing of subterranean clover seed on a purity basis, irrespective of strain. If the seed is found to consist of at least 98 per cent. pure seeds, a slip and tag showing this information are provided and the bag is sealed. During the past season, 290 tons were tested on a purity basis.

Despite the fact that the Agricultural Seeds Act includes a standard of at least 96 per cent. pure seeds for subterranean clover, some farmers still seek seed of low quality at a so-called cheap price and imagine they are securing bargains. The best way to refute this assumption is to quote an actual case which came before our notice recently. A sample submitted by a farmer after purchasing the seed was tested and gave the following results:—

Pure seeds	78.7%	Germination	34%
Weed seeds	.7%	Hard seeds	65%
Inert matter	20.6%	Dead seeds	1%

The inert matter consisted of stick fragments, pebbles and soil particles and the line contained an estimated number of 90 Guildford grass (*Romulea rosea*) seeds and 45 Cape tulip (*Homeria sp.*) bulbils per pound. The actual value, that is, the percentage of pure germinable seeds (including one-third of the hard seeds) is 44 per cent., while that of a good line is in excess of 80 per cent. As, at the time, first grade seed was quoted at 1s. per pound, the sample under consideration had an approximate value of 6½d. per pound. It was purchased for 8d. per pound.

DISSEMINATION OF PESTS.

Further, it contained bulbils of Cape tulip, a very serious weed poisonous to stock, besides sufficient Guildford grass seeds to provide a heavy infestation within a few years. To paint a really black picture, any losses of stock due to Cape tulip poisoning could be debited rationally to the original cost of the seed which was already on the wrong side of the ledger compared with a line of good quality.

To go still further the soil particles present would provide an excellent means of spreading the eggs of such troublesome pests as the red-legged earth mite and clover springtail (lucerne flea). The loss due to their introduction is difficult to assess. This was obviously a flagrant case of false economy.

The cost of seed represents only a fraction of the total cost of establishing a pasture, but unless that seed is capable of producing a satisfactory proportion of vigorous plants without introducing pests—insect pests, disease or weeds—the other operations are nullified to a greater or lesser extent. When buying the super for the same pasture the soluble phosphate content is known and it is equally important to know the purity and germination figures of the seed itself. No amount of cultivation and super application will produce a satisfactory pasture from low grade seed.

Some farmers actually ask for seed containing grit and soil particles, claiming that the bacteria so necessary for the prolific growth of clovers is carried on these impurities. This is frequently quite true but, at the same time, these same particles may be transporting thousands of eggs of the red mite and lucerne flea When we realise that the necessary bacteria can be introduced by means of cultures obtainable at a small charge from this Department without the risk of introducing insect pests the claims for this type of seed become groundless.

"COATY SEEDS" AND "HARD SEEDS."

You may have heard the expression "coaty seeds." These are seeds from which the pod or covering has not been removed during the cleaning operations. Again the claim is made that these coats act as a transporting medium for the bacteria, but again the advantage is not without its usually more than counterbalancing disadvantages. Coaty seeds of this nature cannot be graded and cleaned to the extent of completely hulled seed and consequently there is a greater risk of harmful impurities.

The germination aspect is also affected. Seeds which still remain in their pods have undergone little or no abrasion during the machining operations and contain a high percentage of so-called hard seeds. These do not absorb moisture readily and may remain in the soil in a dormant condition for a period of years. They represent a factor in maintaining subterranean clover pastures, but their main value becomes evident in the years following the initial sowing. Seed resulting from the previous season's crop lies on or just under the soil surface and germination of a considerable percentage may be induced by early rains, only for the seedlings to be killed by a lengthy period of dry weather. When the regular winter rains commence some of the seeds with a degree of hardness which did not respond to the unseasonal rains will produce plants. Others with a greater degree of hardness will remain in the soil in a viable condition for still longer periods. The 1939 season in Western Australia supplied an example of this natural provision. In many districts paddocks green with subterranean clover seedlings resulted from the heavy rains experienced in February. On many areas a large percentage of these seedlings died owing to lack of moisture, but the reserve supply of seed remaining in the soil was sufficient to originate a satisfactory pasture with the regular April-May rains.

When the farmer himself is able to regulate the time of sowing, however, a high hard seed content loses much of its useful properties; in fact, in the main must be regarded as a disadvantage as the usual requirement is a quickly formed pasture with as low seeding rate as possible. Naturally this will not be secured if a high percentage of the seed sown remains dormant for an appreciable period.

Seed purchases are frequently made in a most haphazard manner without giving any consideration to strain, purity and germination. The importance of these three aspects cannot be overstressed. By purchasing certified seed farmers are assured of the correct strain and a satisfactory pure seeds content. Information concerning germination may be secured by submitting a sample or referring the certificate number on the bag to the Department of Agriculture.

TOBACCO GROWING IN WESTERN AUSTRALIA.

(Continued.)

A. SHARP, Tobacco Adviser.

Fertiliser.

The fertiliser in general use in this State is a "complete" one having an analysis of 3.3 per cent. nitrogen, part of which is supplied in the form of ammonia, 15.5 per cent. phosphoric acid and 5.7 per cent. potash. This fertiliser is obtainable mixed ready for use, or it can be made up according to the following formula:—

100 lbs. sulphate of ammonia.
50 lbs. nitrate of soda.
600 lbs. 22 per cent. superphosphate.
100 lbs. sulphate of potash.

The usual rate of application is from 10 to 12 cwt. per acre. Heavier dressings than this are sometimes given but are not recommended owing to the tendency to produce a thick, coarse leaf, particularly on the more fertile types of soil.

It is recognised in most tobacco growing countries that the finest quality leaf is obtained when part of the nitrogenous portion of the fertiliser is derived from organic sources such as dried blood, fish manure, cottonseed meal and so on. Experiments carried out at Manjimup by the Department over a period of five years, however, have shown that replacing the sulphate of ammonia by equivalent amounts of dried blood, fish manure or stable manure has given little or no improvement either in quantity or quality of leaf.

Preparation of Land for Planting.

When the soil has been worked to a fine tilth the rows are struck out at intervals of 3 feet to 3 feet 6 inches. The furrows should be about 4 to 6 inches deep and should preferably have a broad, flat bottom. A double-board drill plough or heavy scuffler fitted with hilling attachment are suitable implements for this operation. If neither of these is available an ordinary mouldboard or disc plough may be used. The fertiliser is applied in the furrow thus made, care being taken to spread it in as broad a band as possible. The furrow is then filled in, preferably with a scuffler with the hilling attachments reversed. This will thoroughly incorporate the fertiliser with the soil as well as fill in the furrow. The plants are set out directly above the band of fertiliser, and in order to obviate possible injury to the roots it is advisable not to plant out until a week or ten days after the fertiliser has been applied.

The method in vogue in most tobacco growing countries of setting out the plants on ridges is not practised in Western Australia owing to the danger of the ridges drying out. Under the climatic conditions obtaining here every effort must be made to conserve soil moisture as much as possible, and it is quite a common practice to only partly fill in the furrow and set the plants out in a slight hollow rather than on a ridge, the hollow being filled in by subsequent cultivation. On thoroughly well drained land or for late planting this method can be recommended.

Spacing of Plants.

The plants are usually set out from 2 feet to 3 feet apart in the rows. Generally speaking, varieties which may tend to produce a rather heavy leaf, such as Hickory Pryor, are best planted fairly closely, particularly on the more fertile

types of soil, while lighter varieties are frequently planted a full 3 feet apart and "on the square" so as to allow of horse cultivation in two directions during the early stages of growth, thus minimising hand labour.

The number of plants required will vary from about 5,000 to 7,000 per acre according to spacing.

Transplanting.

Practically all transplanting in this State is done by hand. The presence of large numbers of dead trees and stumps, which are extremely expensive to remove, on most of our tobacco plantations, together with the comparatively small scale on which most of our growers operate, militate against the use of the mechanical planter.

Planting out may be done from the middle of September until well into November, but it is considered that early October in the best time. As a rule, the weather experienced at Manjimup then is ideal for the purpose, being dull and cool with frequent showers.

If possible, the plants should be set out in the field within a few hours of being lifted from the seed-bed. In this respect the man who grows his seedlings on his own farm is in a much better position than the one who has to obtain his plants from a distance. The plants are dibbled in with the aid of a short dibbling stick, and the most satisfactory way of working is to have one person dropping the plants at the proper intervals along two rows with two others following immediately after to plant them. The plants should be set well down and the soil pressed firmly around the roots. It is very seldom that artificial watering is necessary at Manjimup unless planting has been delayed until well into November.

As the soils in the Manjimup district are heavily infested with subterranean clover weevil and, to a less extent, with cutworms and slugs, all of which are extremely partial to young tobacco, it is absolutely necessary to spread poison bait round the seedlings immediately after transplanting. A suitable bait is made by mixing 1 lb. of Paris Green in 40 lbs. of bran and moistening the mixture with about 3 lbs. of molasses dissolved in sufficient water to make a crumbling mash. This bait should not be allowed to touch the plants as the Paris Green may injure them. It should be laid late in the afternoon so that it is fresh and tempting when the insects come out at night to feed.

Where thoroughly healthy, well grown seedlings have been used and transplanting done carefully, very little replanting should be necessary. It is advisable, however, to go over the ground about four to six days after planting out and replace any seedling which appears to be failing.

Cultivation.

In about ten days after transplanting the seedlings will have become well established and cultivation may then be commenced. The ground between the rows may be stirred with the horse hoe, and the soil immediately surrounding each plant should have the crust broken to a depth of an inch or so with a hand hoe or rake. Great care should be taken not to cultivate too deeply close to the plants as this would disturb the roots and check growth.

From this time onwards the crop should receive frequent cultivations with both horse and hand hoe in order to keep down weed growth, aerate the soil and conserve moisture. The importance of this procedure cannot be emphasised too strongly. Probably no crop responds more to frequent and thorough cultivation during its growth than does tobacco. The object of the grower should be to keep

the plants growing steadily without a check of any kind, as it is only by so doing that first class leaf will be obtained. The advent of hot, dry weather conditions, which usually takes place during December, is likely to give a rather severe check to any crop which has to compete with weeds for the available soil moisture. Cultivation should be continued until the plants have reached such a size that further passage of the scuffler is likely to cause injury to the leaves.

Priming.

When the plants have reached a height of about 9 inches two or three of the bottom leaves should be removed, this operation being known as priming. These bottom leaves are small and of poor quality, and are usually more or less damaged by the lesions of downy mildew (blue mould), and the nourishment required by them is better diverted to the better quality leaf higher up the plant. The lowest leaf left on the plant should be well clear of the ground.

Insect Control.

Young tobacco is particularly susceptible to serious injury by insect pests. The most important of these in Western Australia are leaf-eating caterpillars, budworm and leaf miner. The plants must be kept well protected from attack by these pests by regular spraying or dusting with insecticide. Spraying with liquid insecticides is probably the more effective method, but involves rather more trouble than the use of poison dusts, consequently the latter method is the one in general use. An excellent poison dust is made by mixing 1 lb. of powdered lead arsenate in 20 lbs. of pollard. This can be applied to the plants by placing it in a small bag made of muslin or some other porous material. The bag is given a shake over each plant, thus distributing a small amount of poison over the leaves and growing tip. Dusting should be begun within a fortnight of planting out and should be continued at intervals of about 12 days until the plants are almost ready for topping.

Topping and Suckering.

The natural objective of any plant is the production of seed, and to enable it to do so large quantities of food materials are elaborated in the leaves. The tobacco plant is grown commercially for the sake of its leaf only, however, and in order to force the plant to confine its energy to the production of the maximum amount of leaf and to conserve the substances elaborated therein, the flower head is broken off, the operation being known as "topping." It will usually be found that the flower heads of some plants emerge earlier than others, and it is considered the best practice to wait until the more backward plants are ready before commencing to top, even if the more forward ones are showing a few open flowers. The simultaneous topping of all plants tends to bring them to maturity together.

The height at which the plants should be topped depends on their vigour and on weather and soil conditions, and a certain amount of experience is necessary to determine just how many leaves the plant is likely to be able to mature. If the plant is topped too low the leaves will be coarse and heavy, will mature very slowly and be very difficult to cure. On the other hand, too high topping increases the proportion of small narrow top leaves and reduces the body of the others. Generally speaking, a medium crop can be topped to about 14 leaves while a very vigorous one growing on land with an ample reserve of moisture can frequently mature up to twenty or even more leaves per plant. On the whole it is safer to top a little too high than too low.

After topping, the plant continues to endeavour to produce seed by sending out suckers from the axils of the leaves. These suckers must be removed when about 3 or 4 inches long otherwise they will rob the leaves of nutriment, with consequent reduction of size and quality. The process of suckering is a somewhat tedious one and, as the plants continue to send out fresh suckers to replace those removed, it has to be carried out several times. Many growers cease suckering after harvesting of the bottom leaf has commenced. They maintain that the presence of suckers helps to prevent the top leaf from going thick. It is very doubtful if this argument is soundly based. Experimental work in America has shown that the plant should be kept free of suckers if leaf of high quality is to be obtained. It is probable that higher topping together with rigid suppression of suckers until harvesting is finished will give the best results.

MORE SHEEP IN THE EASTERN WHEAT BELT.

W. M. NUNN, Agricultural Adviser.

With a poor outlook for wheat prices for some time to come, following as it does, so far as growers in the north-eastern wheat areas are concerned upon a succession of years of unfavourable growing seasons and low yields, many farmers are turning from wheat to study other avenues of production. While some feel confident that legislation will yet be passed to assure them a stabilised payable price for wheat, and others are turning to pigs, the majority are considering that sheep will become the more important source of income.

The usual farm in these areas is 1,000 acres and has grown about 300 acres of wheat per year on a three-year rotation of fallow, wheat, pasture. The term "pasture" is, of course, a misnomer, as only a poor stand of barley grass is obtained in the year following the crop and its carrying capacity is very low.

The problem confronting the farmer who desires to limit his wheatgrowing and to increase his returns from sheep is how to improve his carrying capacity—i.e., how to carry more sheep than he is carrying under his present system.

For several years repeated attempts have been made, both by the Department of Agriculture and by private farmers, to introduce pastures to the lower rainfall areas of the wheat belt. Though some species have given promise enough to convince us that they would grow successfully in satisfactory seasons, they have failed in recent years on account of dry conditions and the depredations of grasshoppers. Though seasons may improve and pastures may be established, it is not to be expected that they will have the carrying capacity or permanency of pastures in the more favoured districts, and when dry seasons return—as those in the north-eastern districts must surely expect after the evidence of the last five years—pastures will again fail.

It is essential, therefore, that those who are setting out to increase their flocks should thoroughly investigate the possibilities of increasing their carrying capacity by judicious hand-feeding, even while persisting with their endeavours to improve the feeding value of their pastures.

In the September, 1937, issue of this Journal is published an article on the conservation of fodder in the wheat belt. In this article the author (Mr. F. L. Shier) draws attention to the fact that the wheat belt areas experience two main seasons annually, the wet portion—during which the growth of crop and pasture

takes place—and the dry period when there is no growth at all. He points out that the dry period, frequently and aptly referred to as the annual drought, lasts up to six or seven months and suggests that the obvious method of carrying stock economically through the year is to conserve fodders which have been grown during the winter and spring for feeding during the late summer and autumn.

Adopting the basis for arranging reserves of fodder arrived at and explained in this article, provision should be made every season for—

1. Sufficient hay to supply all the sheep at the rate of 1 lb. per head per day for a period of four months.
2. Sufficient grain, oats or wheat, to supply weaners and mated ewes with ½ lb. per head per day for three months.
3. Where early lambs are being produced and no green feed is expected, silage should be conserved to supply the ewes with 2 lbs. per head for three months.

These figures represent a sufficient supplementary ration when the natural grazing becomes poor and the best of the stubble has been eaten out. One pound per head of good hay meets the requirements of all dry sheep and the half pound of grain supplies the extra growth and production requirements of the weaners and mated ewes, while the 2 lbs. of silage supplies the succulent laxative feed which is so essential for milk production.

Now, take the case of the farmer with 1,000 acres of cleared cultivable land, who has been harvesting 300 acres of wheat yearly and who now wishes to increase his flock of sheep from its present figure of 200-300 head. Let us see what conservation would be necessary to carry, say, 500 sheep through the summer and autumn months working from the basis suggested above, and then consider whether or not it would be possible to grow this fodder during the winter and spring without undue increase in cropping, and still carry the sheep through these months—and also whether or not it would be economical to do so.

Three different policies are open to such a sheep owner. He may use merino rams and rear his own ewe weaners to replace culled ewes; he may use Dorset Horn rams and sell the lambs as suckers for local consumption or for export should they reach export standard; or he may use one of the long wool British breeds.

It is not intended to discuss these policies except to say that the latter is the one recommended. In this case not only has the farmer the opportunity of selling his lambs either to the exporter or for local consumption, but if the season is poor and he is forced to carry over a large percentage, he will have a further avenue of disposal. The ewe progeny from the long wool cross will find a ready sale amongst the export lamb breeders in the more favoured districts.

If more farmers in the wheat belt can be persuaded to breed the long wool cross-bred mother of the export lamb, it should greatly assist the endeavours which are being put forward to improve the State's lamb export trade. Furthermore, it is earnestly believed that the demand for such cross-bred ewes will enormously increase and that high prices will be offered—certainly for the grown ewe and probably for the ewe as a lamb. The use of one of the long wool breeds is a type of cross-breeding which can undoubtedly be profitably undertaken in the Eastern wheat belt.

For the purposes of this article and the calculation we are about to make, it need make no difference which policy is being considered. In one case weaners have to be reared, while in another all progeny are sold as suckers. However, if weaners are reared an equal number of ewes must be culled and in our adopted

basis the feed requirement is the same for a weaner as for a mated ewe, so that in each case we have 500 sheep to be fed one pound of hay per day for four months and half a pound of grain per day for three months.

The quantities required to provide for such feeding are shown below:—

Number of Sheep.	Ration.	Period.	Amount to Conserve.	Area Required.
500	1 lb. Hay	4 months	27 tons	30 acres
500	½ lb. Oat Grain	3 months	250 bags	50 acres

The areas required for the production of these fodders will, of course, vary considerably with the district, the soil and the season, but the assumed figures above are surely within reach of all in average seasons.

Thus about 80 acres of cropping would supply the conservation requirements for the period of total hand-feeding as set out in the article mentioned previously, but the usual cropping programme is in the vicinity of 300 acres.

It is not intended to state what number of sheep could be safely grazed throughout winter and spring by the farmer who is able to stock up knowing that conserved fodder is assured to see him through the summer and autumn, because conditions will vary so greatly in different districts and different seasons. It is suggested, however, that with the assistance of some cheaply scratched-in cereal for grazing purposes and some further conservation in addition to above basic requirements, considerably more sheep could be carried than at present. Surely with wheat at its present price it will pay to conserve large reserves of fodder and to obtain a price for it through the wool and lamb returns rather than to market the lot as wheat grain.

Silage has been left out of the estimated conservation requirements so far because it is not in all cases warranted, and we have been adhering to the minimum requirements for satisfactory feeding. Where lambs are dropped before green feed is available, silage should certainly be provided for the milking ewe. Silage is very simply made in trenches anywhere in the wheat belt and is of inestimable value as a substitute for green feed. It lasts indefinitely as a reserve of fodder and every farmer who has stock to provide for in uncertain districts should take the opportunity this season of ensiling reserves against the probability of feed shortages in later years.

The above estimated yields, areas and suggested requirements for a flock of 500 sheep should serve as a guide to the farmer who has difficulty in deciding how much of his crop he should cut for hay or for silage. Even for a much larger flock of sheep the suggested programme is not an alarming one and this season farmers in most districts should take the opportunity after the lessons of recent drought years, of conserving both hay and silage as fodder reserves against future bad seasons in addition to the ordinary yearly requirements.

Ample provision should, of course, be made for all other farm stock, including horses, cattle, pigs and poultry.

Should a farmer intend devoting portion of his present wheat production to the feeding of a greater number of sheep, there are many points not touched on here for him to consider. He should make every endeavour to increase the carrying capacity of his pasture and with this end in view, it would probably be advisable to make some alteration in his system of rotation. An article by Dunne and Shier in the June, 1934, issue of this Journal gives interesting and useful suggestions on this matter.

In conclusion, the main points are repeated for emphasis. Present indications are not promising for wheat prices, these may be so low that, in many cases, there may be little or no profit to the grower. The North-Eastern wheat belt is experiencing its first favourable season since 1934 and excellent hay crops are to be seen everywhere. Farmers are urged to remember how short of feed they were in recent years and to take this opportunity of conserving large reserves. Hay cutting time does not last long and this article is intended not only as a guide to those who would carry more sheep, but as a suggestion to all farmers while there is still time—while the crops are yet in the hay-cutting stage—that value can be obtained from them despite the low price of wheat.

THE OFFICIAL PURE BRED DAIRY CATTLE PRODUCTION RECORDING SCHEME 1938-39.

Conducted by Officers of the Dairy Branch, Department of Agriculture.

It is pleasing to note in the results shown below that the standard of butter-fat production in pure-bred herds during the past year has been maintained, this mainly being due to supplementary feeding of conserved fodder during the dry months.

Of the 421 sets of results, 46 cows were either sold or withdrawn owing to sickness after having been tested less than 150 days, and in consequence their productions do not figure in any of the averages.

The remaining 375 cows averaged 6,433 lbs. milk, 4.55 per cent. test and 292.40 lbs. of butter-fat, without allowances, and although this butter-fat figure is nearly six pounds lower than last year, the percentage of cows passing the standard is considerably higher, particularly in the Jersey breed, which showed only 35.6 per cent. of passes last year, the lowest percentage for many years.

Table I. below sets out the position according to breeds and age classes.

TABLE I.

	A.I.S.		Guernsey.		Jersey.		All Breeds.	
Age Class.	No. Cows Tested.	No. Passing Standard.	No. Cows Tested.	No. Passing Standard.	No. Cows Tested.	No. Passing Standard.	No. Cows Tested.	No. Passing Standard.
Mature	43	17	27	14	34	11	104	42
Senior (4 years)	15	5	4	3	7	2	26	10
Junior (4 years)	20	10	2	2	4	1	26	13
Senior (3 years)	10	3	6	5	12	7	28	15
Junior (3 years)	33	27	12	10	12	10	57	47
Senior (2 years)	25	12	5	4	19	14	49	30
Junior (2 years)	36	24	21	17	28	19	85	60
Totals ...	182	98	77	55	116	64	375	217
Per cent. Passing Standard ...	53·8		71·4		55·2		57·9	

There is every reason to believe that the percentages above will improve during the next few years as it will be seen that the number of passes amongst the young cows is much higher than in the senior 4-year-old and mature classes.

The present good price for butter-fat and the keen demand for bulls ex high producing dams should be an incentive to breeders to cull out low producers, and by judicious feeding, which includes up-to-date methods of pasture management, build up a herd of high producing cattle which would remain profitable in the event of a drop in the price of butter-fat.

TABLE II.

AVERAGE BUTTER-FAT PRODUCTION IN EACH CLASS.

Age Class.	A.I.S.		Guernsey.		Jersey.		All Breeds.	
	No. Cows.	Average Butter-fat.	No. Cows.	Average Butter-fat.	No. Cows.	Average Butter-fat.	No. Cows.	Average Butter-fat.
Mature	43	331·62	27	349·73	34	310·97	104	329·57
Senior (4 years)	15	319·09	4	372·80	7	326·50	26	329·35
Junior (4 years)	20	309·82	2	403·65	4	307·38	26	316·66
Senior (3 years)	10	251·87	6	322 45	12	269·97	28	274·76
Junior (3 years)	33	302·49	12	315·95	12	311 48	57	307·24
Senior (2 years)	25	243 95	5	308·31	19	262·04	49	257·51
Junior (2 years)	36	240·60	21	256·62	28	239·39	85	244·16

In the above table the average butter-fat productions, according to age-class and breed, are shown and it will be seen that the senior 3-year-old and mature classes are responsible for the lowering of the general average, the A.I.S. breed being particularly low in the former class and Jerseys in the latter.

Although a general improvement throughout the scheme should be evident from year to year, it must be borne in mind that results are affected materially by changes in the personnel of the owners of herds under test. Thus, several familiar names are missing from Table III. and fresh names appear, such as that of Mr. W. Darnell of Rosa Brook, who is to be congratulated on his results after only one year of testing.

With the exception of last year, the A.I.S. breed has provided the Champion Herd Sire for many years, and the success this year of the Queensland bred "Blacklands Monarch's Commander" (1877) owned by Mr. W. G. Burges, has added to the list drawn from this popular breed. His six leading daughters, comprising two junior 2-year-olds, one senior 2, two junior 3-year-olds and one junior 4, averaged 379.83 lbs. of butter-fat, or with age allowances, 459.70 lbs. of butter-fat.

A trophy presented by the Jersey Herd Society to the owner of the six leading Jersey cows, with age allowances, was won by Mr. A. J. B. Strempel with an adjusted average of 461.51 lbs. These six cows however, were not all by the same sire.

Detailed results of all tests completed during the year are shown in Table III.

TABLE 3.

Cows which completed Test during 12 months ended 30th June, 1939.

Name of Cow.	Breed.	Herd Book No.	Date of Birth	Date of Calving	No. of Days in Test	Weight of Milk Last day of Test	Weight of Milk for period.	Average Test.	Weight of Butter-Fat for period.	Owner	Sire.
COWS UNDER 2½ YEARS—STANDARD 230 LBS. BUTTER-FAT											
						lb	lb	%	lb		
Greenmount Marinora's Model	Jersey		3–4–36	27–5–38	273	14	7,040	5·42	381·72	A. J. B Strempel	Bellefaire Bonaparte's Bonetienne (9224)
Wooroloo Flash III.	A.I S.	23243	1–6–36	1–10–38	273	32	8,436	4·42	372·98	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
Tipperary Fairy III.	do.	22905	1–9–36	29–9–38	273	33	8,664	4·28	370·56	W. G. Burges	Blacklands Monarch's Commander (1877)
Greenmount Golden Lass	Jersey		30–9–36	16–9–38	273	16·5	6,350	5·80	368·29	A. J. B Strempel	Bellefaire Bonaparte's Bonetienne (9224)
Travalgan Starbright III.	do.	59778	1–5–36	31–5–38	273	18	6,752	5·25	354·72	Robinson Bros.	Travalgan Northern Noble (10124)
Tipperary Dove V.	A.I.S.	22902	20–8–36	29–7–38	273	22	7,971	4·14	330·35	W. G. Burges	Blacklands Monarch's Commander (1877)
Grass Vale Buttercup IV.	Jersey		11–9–36	6–8–38	273	14	5,652	5·53	312·73	R. H Rose	Selsey Gay Boy (15134)
Glanavon Buttercup	A.I.S.		4–5–36	17–9–38	273	22	6,216	5·01	311·42	D. Bevan & Sons	Blacklands Jean's Supreme (1871)
Denmark Rosemary	Guernsey	5451	7–6–36	7–7–38	273	13	5,649	5·50	310·80	Denmark Research Station	Koojan Golden Prosper (2283)
Wooroloo Jeanette II.	A.I.S	23250	1–8–36	21–8–38	273	21	7,533	4·07	306·58	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
Glanavon Venus II.	do.	20214	4–11–35	3–4–38	273	22	7,431	3·98	295·37	Wooroloo Sanatorium Farm	Villiers of Darbalara (2386)
Koojan Ace's Jean	Guernsey	5660	10–3–36	11–10–37	273	17	5,451	5·39	293·95	A. W. Padbury	Homestead Ace (imp. U.S.A.) (1631)
Koojan Ace's Wavelet	do.	5662	21–11–35	31–3–38	273	16·5	5,690	5·14	292·42	J R. Giles	Homestead Ace (imp. U.S A.) (1631)
Brookfields Golden Queen III.	do.	5324	16–3–36	22–3–38	273	17	5,601	5·21	291·71	P. G. Hampshire	Koojan Ace's Majestic (2735)
Tipperary Beauty IV.	A.I.S.	22897	20–6–36	27–7–38	273	18	6,879	4·21	289·39	W. G. Burges	Blacklands Monarch's Commander (1877)
Wooroloo Empress	do.	23241	1–11–35	6–4–38	273	15	6,975	4·12	288·21	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
Yanget Duchess III.	do.	23297	12–7–36	9–9–38	273	19	6,747	4·25	287·00	A. E. Grant	Blacklands Lancer (1874)
Denmark Wild Rose	Guernsey	6974	1–7–36	22–8–38	273	15	5,595	5·10	285·51	Denmark Research Station	Koojan Golden Prosper (2283)
Muresk Mabel	do.	7644	24–6–36	20–8–38	273	16	5,831	4·86	283·50	Muresk Agricultural College	Minnamurra Plaintiff (1318)
Tipperary Dove 8th	A.I.S.	22904	6–10–36	10–9–38	273	25	6,465	4·32	279·12	W. G Burges	Blacklands Monarch's Commander (1877)
Denmark Pink Pearl	Guernsey	5445	21–5–36	24–7–38	273	15	5,655	4·92	277·90	Denmark Research Station	Koojan Golden Prosper (2283)
Wooroloo Freda II.	A.I.S.	23245	9–10–35	27–3–38	273	19	6,447	4·23	272·42	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
Wooroloo Rose IV.	do.	23269	2–1–36	8–3–38	273	18·5	6,551	4·15	272·29	Wooroloo Sanatorium Farm	Triumph of Pine Creek (2515)
The Wold Starbright Princess	Jersey	64562	4–6–36	11–5–38	273	5·5	4,742	5·68	269·45	L. C. Field	Grantham Air Prince II. (10657)

The Wold Princess Daisy ..	Jersey		7–8–36	11–6–38	240	10·5	4,208	6·34	266·88	L. C. Field	Grantham Air Prince II. (10657)
Brookfields Golden Queen II.	Guernsey	5323	10–2–36	16–11–37	273	16	5,131	5·18	266·16	P. G. Hampshire	Koojan Ace's Majestic (2735)
Grass Vale Golden Cream 15th	Jersey		3–9–36	27–7–38	240	8·5	4,680	5·68	265·77	R. H. Rose	Selsey Gay Boy (15134)
Radyr Park Clarionette ...	do.		9–2–36	13–7–38	273	11·5	4,520	5·85	264·65	L. Temple	Graceful Lad of Greenmount (7292)
Crantock Napoleon's Primula III.	do.		21–6–36	15–3–38	273	17	6,235	4·23	263·84	Mrs. G. H. Burnside	Crantock Blonde's Napoleon (8207)
Denmark Prosperette ..	Guernsey	5446	17–5–36	14–6–38	273	15	5,265	4·98	262·16	Denmark Research Station	Denmark Damon (2519)
Grantham Air Lady III. ...	Jersey	61950	28–4–36	29–5–38	273	7·5	4,283	6·09	258·51	J. A. Sears	Greenmount Black Prince (6511)
Denmark Diana	Guernsey	6963	28–6–36	19–6–38	273	14	4,932	5·22	257·39	Denmark Research Station	Denmark Damon (2519)
Rutherwood Rosella ..	do.	7828	14–8–36	8–10–38	273	14	4,347	5·91	256·87	Misses Rutherford	Denmark Rosa's Prosper (2639)
Denmark Rosette	do.	6972	21–7–36	4–7–38	273	9	4,887	5·22	255·17	Denmark Research Station	Koojan Golden Prosper (2283)
Congelin Velveteen ..	Jersey		4–12–36	5–9–38	273	15	4,673	5·47	254·99	B. P. Hack	Rosecliff Sybil's Mariposa (9997)
The Wold Northwood Crescendo	do.	64559	16–4–36	15–5–38	273	6·5	4,100	6·21	254·44	L. C. Field	Grantham Air Prince II. (10657)
Westby Lupin V.	A.I.S.	23138	23–11–35	27–2–38	273	17	5,976	4·21	252·40	Bayley Bros	Telyarup Duke (956)
Radyr Park Dorothy V. ..	Jersey		18–7–36	10–7–38	273	11	4,473	5·61	251·03	L. Temple	Greenmount Graceful Lad (7292)
Brookfields Lady Charity	Guernsey		27–1–36	13–11–37	273	12	4,461	5·62	250·62	P. G. Hampshire	Koojan Ace's Majestic (2735)
Colmyn Bessie	Jersey	61136	20–5–36	3–7–38	273	12·5	5,303	4·69	248·82	C. H. Ironmonger	Colmyn Prince Victor (10492)
Denmark Velda	Guernsey	6973	13–7–36	23–8–38	273	10	5,160	4·74	244·50	Denmark Research Station	Denmark Damon (2519)
Congelin Rose Marie II. .	Jersey		2–5–36	9–3–38	273	13	4,254	5·74	244·02	B. P. Hack	Clarendon Eyre Oxford Gamboge (10274)
Claremont Hilda V.	A.I.S.	19598	16–11–35	16–5–38	273	20	6,390	3·82	243·98	Claremont Hospital for Insane	Claremont Herdsman (968)
Lansdowne Dairy Miss IV.	Guernsey	5680	24–11–35	21–10–37	273 365	15 20	4,575 6,240	5·33 5·58	243·92 347·96	J. R. Giles	Koojan Ace's Aristocrat (2730)
Yanget Treasure II. .	A.I.S.	23314	29–4–36	19–9–38	273	19	6,162	3·94	243·01	A. E. Grant	Sunrise of Parkview (1875)
Crantock Napoleon's Primula II.	Jersey	61211	7–7–35	13–12–37	273	13	4,223	5·70	240·92	Mrs. G. H. Burnside	Crantock Blonde's Napoleon (8207)
Koojan Ace's Marietta	Guernsey	7243	11–9–36	6–5–38	273	10	4,200	5·73	240·56	A. W. Padbury	Koojan Ace's Aristocrat (2730)
Walgett Handsome Girl VII.	Jersey		8–4–36	24–4–38	273	6	4,481	5·35	239·98	C. J. Cunningham	Sabina Vale Betty's Beau (10018)
Glanavon Daphne II. .	A.I.S.		15–12–35	20–11–37	273	19	5,937	4·04	239·94	D. Bevan & Sons	Parkview Commodore (306)
Rutherwood Dame	Guernsey	7825	9–7–36	18–6–38	273	14·5	4,889	4·90	239·75	Misses Rutherford	Denmark Damon (2519)
Claremont Cocky 11th	A.I.S.	19597	25–1–36	3–5–38	273	16·5	5,705	4·20	239·57	Claremont Hospital for Insane	Tipperary Virginia's Re-echo (970)
Glanavon Dell II. .. .	do.		26–10–35	23–3–38	273	18	6,534	3·65	238·28	D. Bevan & Sons	Parkview Commodore (306)
Glanavon Gold II.	do.		7–8–35	20–10–37	273	21	5,523	4·30	237·69	D. Bevan & Sons	Glanavon Nimrod (437)
Glanavon Thelma	do.		1–3–36	13–8–38	273	12	5,406	4·39	237·59	D. Bevan & Sons	Glanavon Nimrod (437)
Yanget Victress .	do.	18662	29–7–35	22–10–37	273	17	5,639	4·19	236·11	A. E. Grant	Sunrise of Parkview (1875)
Colmyn Topsy .	Jersey		1–10–36	3–8–38	273	11	5,618	4·19	235·88	C. H. Ironmonger	Colmyn Prince Victor (10492)
Glanavon Gem ...	A.I.S.		18–11–35	5–4–38	273	15	5,115	4·69	235·77	D. Bevan & Sons	Glanavon Nimrod (437)
Glanavon Doris III. ..	do.		14–11–35	18–11–37	273	14	5,562	4·22	234·87	D. Bevan & Sons	Parkview Commodore (306)
Claremont Lily 7th..	do.	19599	17–12–35	15–3–38	273	19	6,237	3·75	234·04	Claremont Hospital for Insane	Wooroloo Persimmon (2972)
Yanget Lucky Pendant .	do.	23303	25–6–36	9–9–38	240	16	6,630	3·51	232·86	A. E. Grant	Blacklands Lancer (1874)
Walgett Lily ..	Jersey	64784	9–5–36	12–5–38	273	7·5	4,223	5·45	230·19	C. J. Cunningham ..	Sabina Vale Betty's Beau (10018)
Glanavon Dahlia IV.	A.I.S.		4–3–36	23–3–38	273	16	5,688	4·04	230·09	D. Bevan & Sons	Parkview Commodore (306)
Muresk Opal .	Guernsey	7646	27–8–36	4–9–38	273	18	4,779	4·78	228·81	Muresk Agricultural College	Minnamurra Plaintiff (1318)
Claremont Maggie 8th ...	A.I.S.	19604	12–11–35	25–3–38	273	17·5	5,663	4·02	227·47	Claremont Hospital for Insane	Wooroloo Persimmon (2972)
Walgett Handsome Girl VI.	Jersey	...	10–3–36	14–4–38	273	6	3,768	5·98	225·37	C. J. Cunningham	Sabina Vale Betty's Beau (10018)

HERD TESTING—*continued.*

Name of Cow.	Breed.	Herd Book No.	Date of Birth.	Date of Calving.	No. of Days in Test.	Weight of Milk Last day of Test	Weight of Milk for period.	Average Test.	Weight of Butter-Fat for period.	Owner.	Sire.
COWS UNDER 2½ YEARS—STANDARD 230 LBS. BUTTER-FAT.—*continued.*											
						lb.	lb.	%	lb.		
Denmark Bonnie	Guernsey	5437	22-7-35	30-9-37	273	12·5	4,808	4·67	224·67	Denmark Research Station	Denmark Damon (2519)
Glanavon Dahlia III.	A.I.S.		9-11-35	24-1-38	273	18	5,064	4·27	216·25	D. Bevan & Sons	Parkview Commodore (306)
Travalgan Lady Eion II.	Jersey	59777	29-9-36	5-6-38	273	11	3,708	5·74	212·34	Robinson Bros	Travalgan Northern Noble (10124)
Claremont Treasure 13th	A.I.S.		18-4-36	20-8-38	273	18·5	5,321	3·89	207·27	Claremont Hospital for Insane	Claremont Kandor (1964)
Denmark Golden Day	Guernsey	5440	29-7-35	2-11-37	273	14	4,047	5·06	205·38	Denmark Research Station	Denmark Damon (2519)
Claremont Rachel 10th	A.I.S.		23-3-36	19-8-38	240	13	5,070	3·99	202·56	Claremont Hospital for Insane	Claremont Herdsman (968)
Claremont Whitby Maid 24th	do.	19618	24-12-35	9-3-38	273	15	5,115	3·85	197·19	Claremont Hospital for Insane	Wooroloo Persimmon (2972)
Walgett Pride's Lady	Jersey	64785	23-3-36	24-4-38	273	6·5	3,725	5·22	194·39	C. J. Cunningham	Sabina Vale Betty's Beau (10018)
Claremont Cleggett 11th	A.I.S.		9-6-36	20-8-38	273	14	4,857	3·96	192·28	Claremont Hospital for Insane	Claremont Herdsman (968)
Crantock Napoleon's Daisy	Jersey	61210	26-7-35	22-10-37	273	16	4,023	4·80	192·10	Mrs. G. H. Burnside	Crantock Blonde's Napoleon (8207)
Wallatin Fussy	A.I.S.		27-5-36	12-9-38	240	20	4,515	4·08	184·20	Prowse Bros.	Lemon Grove Myrtle's Heir (1453)
Claremont Biddy 31st	do.	19590	14-1-36	28-4-38	273	11	4,623	3·90	180·36	Claremont Hospital for Insane	Wooroloo Persimmon (2972)
Rutherwood Jonquil	Guernsey	6263	18-5-36	13-3-38	273	12	3,299	5·38	177·40	Misses Rutherford	Koojan Forty Winks (2738)
Glanavon Tiny II.	A.I.S.		15-9-35	28-10-37	240	15	4,320	3·94	170·19	D. Bevan & Sons	Glanavon Nimrod (437)
Congelin Firefly II.	Jersey		3-10-36	17-9-38	210	9·5	2,879	5·87	168·71	B. P. Hack	Clarendon Eyre Eminent's Geishar IV. (13597)
Yanget Daphne II.	A.I.S.	23295	6-3-36	24-11-37	273	14	4,290	3·86	165·90	A. E. Grant	Yanget Emperor (2982)
Longridge Melba VI.	do.		20-1-37	20-8-38	150	15	3,480	4·62	160·89	R. Bee & Sons	Minathorpe Kitchener (434)
Byrine Blossom	Jersey		4-8-36	26-7-38	180	7	3,780	4·09	154·53	E. Loynel	Juadine Robin (11751)
Sabina Vale Water Lily	do.		3-7-36	7-5-38	180	13	2,730	5·60	152·31	Sabina Vale Stud Farm	Banyule Ettric (9200)
Brackenhurst Fussy	A.I.S.	19312	30-4-36	5-5-38	180	14	3,360	4·21	141·36	W. G. Burges	Thornleigh Champagne (930)
Byrine Lady Bright	Jersey		11-8-36	11-7-38	180	6·5	2,625	4·13	108·42	E. Loynel	Juadine Robin (11751)
Muresk Holly	Guernsey	7639	11-10-36	28-8-38	120	13	2,145	4·37	93·72	Muresk Agricultural College	Koojan Ace's Goldseeker (3431)
Nooka Milkmaid II.	Jersey		8-7-36	11-6-38	180	10·5	2,475	3·56	87·98	E. Loynel	Pella O.K. (9913)
Radyr Park Melody II.	do.		8-11-36	25-1-39	120	9·5	1,425	6·14	87·90	L. Temple	Radyr Park Lady's Starlight (13128)
Glanavon Doris IV.	A.I.S.		24-9-36	3-12-38	120	13	2,250	3·81	85·65	D. Bevan & Sons	Parkview Commodore (306)
Drakesbrook Bubbles	Guernsey	6976	29-8-36	18-8-38	90	16	1,860	4·53	84·33	J. Rae	Drakesbrook Jupiter (4029)
Glanavon Dahlia V.	A.I.S.		18-11-36	9-12-38	120	14	2,010	4·05	81·51	D. Bevan & Sons	Parkview Commodore (306)
Glanavon Nancy	do.		5-10-36	2-12-38	120	15	2,100	3·80	79·80	D. Bevan & Sons	Glanavon Ponsford (3202)
Nooka Blossom II.	Jersey		2-5-36	12-9-38	90	17	2,018	3·73	75·24	E. Loynel	Pella O.K. (9913)
Glanavon Champion II.	A.I.S.		14-2-37	17-1-39	90	17	1,890	3·59	67·98	D. Bevan & Sons	Blacklands Jean's Supreme (1871)
Westby Pearl IV.	do.	23144	23-11-36	6-3-39	60	27	1,620	4·09	66·21	Bayley Bros.	Telyarup Duke (956)
Westby Lupin 9th	do.	23142	1-12-36	19-3-39	30	36	1,080	4·10	44·16	Bayley Bros.	Telyarup Duke (956)

COWS 2½ YEARS AND UNDER 3 YEARS—STANDARD 250 LBS. BUTTER-FAT.

Koojan Ace's Jean	Guernsey	5660	10-3-36	23-9-38	273	26·5	6,995	5·75	402·04	A. W. Padbury	Homestead Ace (imp. U.S.A.) (1631)
Tipperary Lady May II.	A.I.S.	18328	8-10-35	25-9-38	273	26	8,868	4·15	367·81	W. G. Burges	Blacklands Monarch's Commander (1877)
Westby Pearl III.	do.	23143	9-1-36	19-7-38	273	24	9,417	3·73	351·69	Bayley Bros.	Telyarup Duke (956)
Westby Carnation II.	do.	18515	12-8-35	12-3-38	273	25	8,250	4·05	334·41	Bayley Bros.	Telyarup Duke (956)
Crantock Golden Duchess	Jersey		8-8-35	3-8-38	273	13	6,084	5·40	328·56	Mrs. G. H. Burnside	Crantock Blonde's Napoleon (8207)
Wattle Creek Viola	A.I.S.		15-2-36	17-9-38	273	31	9,063	3·62	328·06	E. T. Thatcher	Tipperary Violet's Monarch (2876)
Lansdowne Dymphna	Guernsey	5683	15-7-35	1-3-38	273	21	6,063	5·35	324·47	J. R. Giles	Koojan Ace's Aristocrat (2730)
Longridge Bess IV	A.I.S.	17202	10-2-35	14-10-37	273	39	8,037	3·98	319·66	R. Bee & Sons	Longridge Carnation's Emblem (2395)
Radyr Park Dorothy IV.	Jersey	63850	5-10-35	12-7-38	273	14	5,397	5·72	308·90	L. Temple	Greenmount Graceful Lad (7292)
Congelin Firefly	do.		5-9-35	18-6-38	273	12·5	5,798	5·33	308·82	B. P. Hack	Clarendon Eyre Oxford Dreamer (10273)
Denmark Rose Pearl VII.	Guernsey	5449	17-10-34	2-10-37	273	19·5	6,569	4·73	308·48	G. T. Hill	Koojan Golden Prosper (2283)
Longridge Gentle III.	A.I.S.	21222	20-7-35	1-5-38	273	20	7,380	4·18	308·38	Bee & Sons	Minathorpe Kitchener (434)
Grass Vale Rye Cream III.	Jersey		1-10-35	7-6-38	273	15·5	5,267	5·82	306·45	R. H. Rose	Melrose Lost Key (7975)
Sabina Vale Silvermine VII.	do.	64187	18-6-35	15-3-38	240	15	5,640	5·43	306·27	Sabina Vale Stud Farm	Sabina Vale King (12149)
Glanavon Fairy	A.I.S.	20204	22-12-34	6-12-37	273	20	6,990	4·28	299·17	D. Bevan & Sons	Blacklands Jean's Supreme (1871)
Summerlea Spangle XI	do.	App. C.	18-9-35	22-5-38	273	18	7,584	3·94	298·69	Dunkley Bros.	Summerlea Togo (1527)
Grantham Easter Rye IV.	Jersey	57554	18-10-35	18-9-38	273	7	4,776	6·24	297·08	J. A. Sears	Greenmount Black Prince (6511)
Colmyn Janis II.	do.	61139	12-9-35	1-6-38	273	12·5	5,453	5·36	292·30	C. H. Ironmonger	Colmyn Captain Mac (5855)
Radyr Park Melody	do.	59126	26-1-35	18-10-37	273	11·5	4,775	6·02	287·37	L. Temple	Graceful Lad of Greenmount (7292)
Walgett Handsome Girl IV	do.	59901	5-4-35	24-3-38	240	14·5	5,055	5·59	282·66	C. J. Cunningham	Sabina Vale Betty's Beau (10018)
Moorlands Jessamine	do.		26-4-35	20-4-38	210	10·5	5,183	5·21	269·88	Estate late P. Rose	Preston Prospector (11024)
Summerlea Dairymaid 21st	A.I.S.		2-8-35	28-5-38	273	16	7,428	3·59	266·52	Dunkley Bros.	Summerlea Togo (1527)
Grantham Easter Felicity	Jersey	57555	18-9-35	23-7-38	273	8·5	4,271	6·21	265·21	J. A. Sears	Greenmount Black Prince (6511)
Radyr Park Dorothy III	do.	59125	15-11-34	18-10-37	273	10	5,070	5·06	256·37	L. Temple	Graceful Lad of Greenmount (7297)
Claremont Mabel 7th	A.I.S.	19603	29-9-35	31-3-38	273	15·5	6,197	4·10	254·30	Claremont Hospital for Insane	Claremont Herdsman (968)
Colmyn Maley	Jersey		29-6-35	4-6-38	273	13·5	5,711	4·45	254·20	C. H. Ironmonger	Colmyn Captain Mac (5855)
Grantham Princess Starbright III.	do.	57557	20-9-35	9-8-38	273	10	4,470	5·67	253·33	J. A. Sears	Clarendon Eyre Oxford Pioneer (11484)
Colmyn Peggy	do.	61141	26-10-35	5-7-38	273	12·5	5,731	4·41	252·88	C. H. Ironmonger	Colmyn Captain Mac (5855)
Summerlea Sweet Doris VII.	A.I.S.	App. C.	28-9-35	4-5-38	273	10	6,975	3·61	251·55	Dunkley Bros.	Summerlea Togo (1527)
Wooroloo Maggie	do.	23256	13-11-35	21-8-38	210	21	5,820	4·05	235·53	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
The Wold Air Queen	Jersey	59711	23-5-35	2-5-38	240	14	4,470	4·99	233·16	L. C. Field	Grantham Air Prince II. (10657)
Claremont Cherry 11th	A.I.S.	19595	30-10-35	15-5-38	273	17	5,871	3·86	228·18	Claremont Hospital for Insane	Claremont Herdsman (968)
Walgett Jersey Lily	Jersey	59903	4-5-35	24-3-38	240	11	3,900	5·60	218·55	C. J. Cunningham	Sabina Vale Betty's Beau (10018)
Tirano Susie	A.I.S.	22929	1-3-35	13-11-37	273	10	4,565	4·67	213·29	A. Della	Bryn-y-mor Charmer (266)
Capel Daisy III.	Jersey		14-9-35	10-6-38	150	21	4,440	4·58	203·22	B. W. Prowse	Devonia Makarini (8217)
Wallatin Pansy	A.I.S.	23058	25-10-35	30-5-38	273	11	4,788	4·15	198·54	Prowse Bros.	Lemon Grove Myrtle's Heir (1453)
Claremont Lucy 8th	do.		2-12-35	18-8-37	273	18	5,109	3·89	198·17	Claremont Hospital for Insane	Claremont Herdsman (968)
Claremont Maggie 7th	do.		11-10-35	17-7-38	210	22	5,130	3·84	197·07	Claremont Hospital for Insane	Claremont Herdsman (968)
Walgett Joy Bells	Jersey	59904	19-7-35	11-3-38	240	8·5	3,525	5·56	195·96	C. J. Cunningham	Sabina Vale Betty's Beau (10018)
Wallatin Lass	A.I.S.	23057	29-10-35	2-9-38	240	20	4,710	4·07	191·61	Prowse Bros.	Lemon Grove Myrtle's Heir (1453)
Glanavon Eva	do.		20-11-35	10-6-38	240	13	4,770	3·98	190·02	D. Bevan & Sons	Villiers of Darbalara (2386)
Yanget Lady Thelma	do.	23302	17-3-35	18-10-37	273	17	5,259	3·60	189·36	A. E. Grant	Tipperary Topsy's Monarch (2875)
Capel Gladys Queen II.	Jersey		3-9-35	3-5-38	180	19	4,110	4·53	186·15	B. W. Prowse	Capel Carnation's Pride (7988)

HERD TESTING—*continued*.

Name of Cow.	Breed.	Herd Book No.	Date of Birth.	Date of Calving.	No. of Days in Test.	Weight of Milk Last day of Test	Weight of Milk for period	Average Test.	Weight of Butter-Fat for period.	Owner	Sire.
COWS 2½ YEARS AND UNDER 3 YEARS—STANDARD 250 LBS. BUTTER-FAT—*continued*.											
						lb.	lb.	%	lb.		
Drakesbrook Princess	Guernsey	6986	13-8-35	11-6-38	180	16	3,863	4 61	178 00	J. Rae	Koojan Lord Barclay (1031)
Capel Princess	A.I.S.	19486	22-9-35	28-4-38	210	7 5	3,765	4·21	154 53	B. W. Prowse	Wooroloo Premier VI. (2973)
Yanget Daphne II.	do.	23295	6-3-36	15-9-38	240	7	3,780	3 95	149·34	A. E. Grant	Yanget Emperor (2982)
Brackenhurst Dairymaid	do.	19306	8-11-35	27-5-38	180	19	4,170	3 45	144 09	B. W. Prowse	Thornleigh Champagne (930)
Capel Model	do.	19485	2-8-35	15-6-38	150	20	3,600	3·84	138·33	B. W. Prowse	Thornleigh Champagne (930)
Capel Noraleda II.	Jersey	60992	3-8-35	20-7-38	120	17	2,400	5 28	126·72	B. W. Prowse	Capel Carnation's Pride (7988)
Westby Lupin IV.	A.I.S.	18517	1-8-35	7-3-38	120	16	2,370	4 07	96 42	Bayley Bros.	Telyarup Duke (956)
Drakesbrook Bluebell	Guernsey	6975	11-10-35	25-8-38	90	24 5	2,205	3 91	86 04	J. Rae	Koojan Lord Barclay (1031)
Glanavon Lex	A.I.S.		12-2-36	21-12-38	120	15	2,220	3·80	84 27	D. Bevan & Sons	Glanavon Nimrod (437)
Walgett Sweet Duchess	Jersey	59906	23-5-35	19-4-38	69	23 5	1,350	4 08	55 02	C. J. Cunningham	Sabina Vale Betty's Beau (10018)
COWS 3 YEARS AND UNDER 3½ YEARS—STANDARD 270 LBS. BUTTER-FAT.											
Denmark Dawn II.	Guernsey	5439	21-3-35	3-8-38	273	21	8,613	5 61	483 01	Denmark Research Station	Koojan Golden Prosper (2283)
Wooroloo Poppy II.	A.I.S.	23265	4-5-35	29-8-38	273	17·5	10,253	4 19	429 60	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
Koojan Ace's Jewel II.	Guernsey	5661	4-3-35	14-4-38	273	21 5	8,207	5 01	411 10	A. W. Padbury	Homestead Ace (imp. U.S.A.) 1631
Tipperary Beauty III.	A.I.S.	18315	8-4-35	18-8-38	273	28	9,459	4 31	407·99	W. G. Burges	Blacklands Monarch's Commander (1877)
Crantock Cream Duchess II.	Jersey	61209	2-8-35	20-8-38	273	17 5	7,193	5 33	383 79	Mrs. G. H. Burnside	Crantock Blonde's Napoleon (8207)
Norric Peggy	A.I.S.		14-4-35	7-7-38	273	19	9,192	4·06	373·10	W. G. Burges	Warwick Rufus (3595)
Wooroloo Dell	do.	18628	18-10-34	8-4-38	273	9	8,742	4 15	362 49	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
Greenmount Golden Wonder	Jersey	61975	28-3-35	1-8-38	273	12	6,831	5·29	361·34	A. J. B. Strempel	Bellefaire Bonaparte's Bonetienne (9224)
Greenmount Gentle Lady	do.	61973	8-8-35	30-9-38	273	17	6,223	5 79	360·47	A. J. B Strempel	Bellefaire Bonaparte's Bonetienne (9224)
Westby Carnation	A.I.S.	18514	30-5-35	11-9-38	273	23	9,369	3 84	359 95	Bayley Bros.	Telyarup Duke (956)
Congelin Rose Marie	Jersey	61154	5-4-35	12-4-38	273	20 5	6,362	5 61	356 95	B P. Hack	Rochettes Golden (imp.) (7962)
Wooroloo Bonnie	A.I.S.	18626	29-10-34	16-2-38	273	22	8,721	4 09	356·72	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
Brookfields Bonnie Blossom	Guernsey	5319	15-8-34	30-10-37	273	20 5	6,287	5 44	342·05	P. G. Hampshire	Koojan Lord Barclay (1031)
Wooroloo Lady Betty	A.I.S.	18634	3-8-34	20-11-37	273	22	7,686	4·42	340 05	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
Wooroloo Sunshine III.	do.	18638	3-1-35	11-4-38	273	21 5	8,120	4 18	339·72	Wooroloo Sanatorium Farm	Triumph of Pine Creek (2515)
Wooroloo Doll	do.	23237	22-4-35	29-5-38	273	19	7,572	4 38	331·76	Wooroloo Sanatorium Farm	Triumph of Pine Creek (2515)
Wooroloo Matilda II.	do.	15337	22-5-34	21-11-37	273	28	7,779	4·26	331 24	Wooroloo Sanatorium Farm	Triumph of Pine Creek (2515)
Glanavon Doris II.	do.	20200	30-8-34	19-9-37	273	20 5	7,727	4·28	331·11	D. Bevan & Sons	Blacklands Jean's Supreme (1871)

Tipperary Sally	A.I.S.	18338	23–4–35	26–5–38	273	12	8,256	4·00	330·65	W. G. Burges	Blacklands Monarch's Commander (1877)
Glanavon Pink Pearl II. ..	do.	20208	3–9–34	9–11–37	273	16	7,998	4·13	330·48	D. Bevan & Sons	Blacklands Jean's Supreme (1871)
Glanavon Venus	do.	20213	14–10–34	11–11–37	273	20	8,040	4·04	325·04	D Bevan & Sons	Parkview Commodore (306)
Westby Pearl II. . .	do.	18518	28–2–35	10–7–38	273	20	8,310	3·86	320·96	Bayley Bros .	Telyarup Duke (956)
Denmark Irish Rosette ..	Guernsey	5442	27–3–35	23–6–38	273	13·5	6,506	4·93	320·49	Misses Rutherford	Denmark Damon (2519)
Tipperary Dove IV. ..	A.I.S.	18323	18–7–35	10–8–38	273	19	7,197	4·45	319·74	W. G. Burges	Blacklands Monarch's Commander Duke (1877)
Colmyn Brown Maggie .	Jersey	56859	27–6–35	1–8–38	273	11·5	6,605	4·81	317·35	C. H. Ironmonger	Colmyn Prince Victor (10492)
Denmark Golden Day .	Guernsey	5440	29–7–35	19–9–38	273	16	5,598	5·66	316·72	Denmark Research Station	Denmark Damon (2519)
Longridge Melba III. .	A.I.S.	17211	19–6–34	11–11–37	273	24	7,692	4·11	316·60	R. Bee & Sons	Minathorpe Kitchener (434)
Grass Vale Lady Fowler 20th	Jersey	61959	29–5–35	5–8–38	273	12	5,736	5·50	315·54	R. H Rose	Spring Park Starbright's Sweet Duke (8221)
Congelin Tangerine	do.	61156	13–6–35	9–8–38	273	15	6,293	4·96	312·32	B P. Hack	Clarendon Eyre Oxford Gamboge (10274)
Glanavon Tiny	A.I.S.	20212	25–9–34	23–10–37	273	23	7,299	4·32	311·74	D Bevan & Sons	Blacklands Jean's Supreme (1871)
Wooroloo Kitty III. ...	do.	23253	9–7–35	24–9–38	273	26	7,293	4·18	304·95	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
Denmark Rose Pearl 8th ..	Guernsey	5450	23–3–35	30–7–38	273	15	5,813	5·11	296·77	Muresk Agricultural College	Koojan Golden Prosper (2283)
Longridge Royal Lady II...	A.I.S.	17213	10–10–34	16–10–37	273	27	7,191	4·14	295·10	R. Bee & Sons	Minathorpe Kitchener (434)
Norric Daisy Bell .. .	do.		23–4–35	18–9–38	273	11	7,233	4·06	294·00	W. G. Burges	Warwick Rufus (3595)
Wooroloo Yvonne . ..	do.	18639	25–2–35	28–7–38	273	22	6,891	4·22	290·67	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
Yanget Victress .	do.	18662	29–7–35	1–10–38	240	18	7,110	4·03	286·53	A E. Grant	Sunrise of Parkview (1875)
Koojan Ace's Twinkle .	Guernsey	7244	16–11–34	2–3–38	273	20	5,925	4·82	285·57	J. R. Giles	Koojan Ace (2270)
Brookfields Primrose .	do.	5331	24–2–35	28–7–38	210	8·5	5,700	5·01	285·45	W. Darnell	Koojan Ace's Majestic (2735)
Congelin Iolanthe .	Jersey	61152	27–3–35	22–5–38	273	12	6,516	4·38	285·28	B. P. Hack	Rochette's Golden (imp.) (7962)
Wooroloo Sunflower .	A.I.S.	15348	1–8–34	18–10–37	273	17	6,621	4·29	284·40	Wooroloo Sanatorium Farm	Wooroloo Prince (2974)
Crantock Cream Duchess .	Jersey	56952	15–9–34	26–12–37	273	21	4,698	6·00	282·13	Mrs. G. H. Burnside	Crantock Blonde's Napoleon (8207)
Brookfields Mignonette .	Guernsey	5329	18–6–35	9–8–38	240	8	5,535	5·09	282·06	W. Darnell	Koojan Lord Barclay (1031)
Rutherwood Rosette .	do.	6265	23–8–34	4–11–37	273	16	5,006	5·59	279·60	Misses Rutherford	Denmark Rosa's Prosper (2639)
Wooroloo Sunflower II. ..	A.I.S.	18637	3–9–34	25–11–37	273	11	6,168	4·50	277·86	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
Walgett Beau's Ruby ...	Jersey	59900	11–11–34	6–5–38	273	7	5,181	5·35	277·25	C J. Cunningham	Sabina Vale's Betty's Beau (1008)
Yanget Florrie	A I S	18653	18–3–35	10–9–38	273	17	7,221	3·82	275·65	A. E. Grant	Sunrise of Parkview (1875)
Denmark Rose Ophelia .	Guernsey	5448	11–7–35	24–7–38	273	15	5,895	4·61	272·15	Denmark Research Station	Koojan Golden Prosper (2283)
Muresk Tess . .	do	6066	15–5–35	4–8–38	273	11·5	5,105	5·28	269·14	P G Hampshire	Muresk Homestead (2075)
Denmark Atalie	do.	5436	23–6–34	22–12–37	273	20·5	5,997	5·28	264·03	Misses Rutherford .	Koojan Golden Prosper (2283)
Grantham Starbright Queen III.	Jersey	57559	9–8–35	19–9–38	273	10·5	4,352	6·03	262·33	J. A. Sears	Greenmount Black Prince (6511)
Glanavon Esmeralda II. ..	A I.S	20203	11–3–35	5–7–38	273	13	7,149	3·51	251·22	D. Bevan & Sons	Parkview Commodore (306)
Moorlands Josephine	Jersey		24–5–35	28–5–38	210	10·5	4,170	5·35	223·02	Estate late P. Rose	Preston Prospector (11024)
Tipperary Jeanette	A.I S	18327	29–7–35	7–8–38	273	8	5,094	4·15	211·21	W. G. Burges	Blacklands Monarch's Commander (1877)
Tirano Hazel	do.		1–2–35	6–5–38	273	14	5,217	4·02	209·95	A. Della	Bryn-y-mor Charmer (266)
Tirano Peggy ...	do.		1–3–35	4–5–38	273	10	4,860	3·93	191·09	A. Della	Tirano Silver II.
Wooroloo Ruby II.	do.	18636	22–10–34	17–2–38	180	16	4,155	4·18	173·94	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
Tirano Bella .	do	22918	4–10–35	19–12–38	120	17·5	2,940	3·79	110·79	A. Della . .	Tirano Kate's Charmer (2877)
Glanavon Cowslip . .	do	20198	7–12–34	17–2–38	150	16	2,720	4·05	110·13	D. Bevan & Sons ...	Blacklands Jean's Supreme (1871)
Drakesbrook Joy	Guernsey	6980	29–7–35	2–9–38	90	19	2,430	3·90	94·83	J. Rae .. .	Drakesbrook Byron (2649)

HERD TESTING—*continued.*

Name of Cow.	Breed.	Herd Book No.	Date of Birth.	Date of Calving.	No. of Days in Test.	Weight of Milk Last day of Test.	Weight of Milk for period.	Average Test.	Weight of Butter-Fat for period.	Owner.	Sire.
COWS 3½ YEARS AND UNDER 4 YEARS—STANDARD 290 LBS. BUTTER-FAT											
						lb.	lb.	%	lb.		
Moorlands Italy	Jersey		20-7-34	8-4-38	273	14	6,702	5·73	383·72	Estate late P. Rose	Melrose Liberty (7973)
Brookfields Glory	Guernsey	4059	15-3-34	2-1-38	273	22	6,914	5·16	356·95	P. G. Hampshire	Koojan Aces Chancellor (2274)
Brookfields Lady Hope	do.	5325	14-9-34	28-7-38	240	8·5	6,960	5·03	350·54	W. Darnell	Koojan Lord Barclay (1031)
Travalgan Starlight II.	Jersey	55608	4-9-34	30-5-38	273	16	6,243	5·52	344·91	Robinson Bros.	Travalgan Northern Noble (10124)
Claremont Cherry 8th	A.I.S.	19554	11-9-34	1-4-38	273	26	9,378	3·65	342·50	Claremont Hospital for Insane	Claremont Herdsman (968)
Muresk Flossie	Guernsey	6050	5-7-34	4-7-38	273	18	6,684	5·11	341·48	J. R. Giles	Triumph of Wollongbar (513)
Colmyn Pearl	Jersey	52319	25-11-34	3-6-38	273	14	6,057	5·33	323·11	C. H. Ironmonger	Colmyn Captain Mac (5855)
Longridge Handsome	A.I.S.	17209	2-1-34	9-11-37	273	23	7,494	4·25	318·79	R. Bee & Sons	Minathorpe Kitchener (434)
Brookfields Golden Queen	Guernsey	4060	5-1-34	16-11-37	273	23	6,707	4·69	314·86	P. G. Hampshire	Koojan Lord Barclay (1031)
Colmyn Violet	Jersey	52322	6-10-34	4-8-38	273	10	6,330	4·95	313·35	C. H. Ironmonger	Colmyn Prince Victor (10492)
Brookfields Lady Lynette	Guernsey	5327	21-7-34	10-7-38	240	5·5	6,459	4·82	310·71	W. Darnell	Koojan Lord Barclay (1031)
Colmyn Noraleeda II	Jersey	52318	1-8-34	29-3-38	273	18·5	6,371	4·8	305·95	C. H. Ironmonger	Colmyn Captain Mac (5855)
Moorlands Iliad	do.		12-6-34	16-5-38	210	12	5,400	5·61	303·03	Estate late P. Rose	Melrose Liberty (7973)
The Wold Merry Daisy	do.	55528	14-8-34	27-5-38	240	12·5	5,075	5·76	292·59	L. C. Field	Merry King of Greenmount (4306)
Wooroloo Elsie II	A.I.S.	18629	30-10-34	7-6-38	273	19	6,927	4·21	291·70	Wooroloo Sanatorium Farm	Triumph of Pine Creek (2515)
Glanavon Irene	do.	20207	22-8-34	13-6-38	273	14	6,372	4·41	280·85	D. Bevan & Sons	Blacklands Jean's Supreme (1871)
Muresk Moss Rose	Guernsey	6060	17-8-34	26-4-38	273	11	4,608	5·65	260·18	Muresk Agricultural College	Minnamurra Plaintiff (1318)
Glanavon Vera	A.I.S.	16494	14-1-34	18-10-37	273	13	5,919	4·29	253·92	E. T. Thatcher	Glanavon Nimrod (437)
Glanavon Rosalie	do.	20210	12-2-35	17-9-38	273	19	7,107	3·56	253·40	D. Bevan & Sons	Parkview Commodore (306)
Westby Polly III.	do.	18519	4-10-34	23-8-38	273	6	5,546	4·25	235·86	Bayley Bros.	Telyarup Duke (956)
Capel Gladys Queen I	Jersey	60990	21-9-34	20-6-38	150	21·5	4,275	5·28	225·66	B. W. Prowse	Capel Carnation's Pride (7988)
Moorlands Idela	do.		14-10-34	26-4-38	210	4·5	4,050	5·44	220·35	Estate late P. Rose	Preston Prospector (12024)
Tirano Camellia	A.I.S.	18340	13-4-34	13-12-37	273	12	5,421	4·06	219·93	A. Della	Tirano Silver King (1525)
Selsey Ranunculus	Jersey	55209	13-8-34	30-4-38	120	28	3,945	5·52	218·07	Robinson Bros.	Brampton Great Boy (imp.) (9137)
The Wold Merry Northwood	do.	55529	17-8-34	1-6-38	210	9·5	3,840	5·67	217·56	L. C. Field	Merry King of Greenmount (4306)
Leylands Fairy	A.I.S.	17164	2-7-34	6-4-38	273	11	4,323	4·05	175·02	Prowse Bros.	Thornleigh Champagne (930)
Juadine Sparkle 11th	Jersey	57870	14-8-34	7-5-38	210	12	4,290	3·99	171·47	B. P. Hack	Juadine Sunshine (8212)
Tirano Mabel	A.I.S.	18341	12-11-34	9-10-38	180	17	3,570	4·11	146·73	A. Della	Bryn-y-mor Charmer (266)
Capel Pretty I.	Jersey	56710	16-8-34	20-7-38	120	21	3,090	4·47	138·78	B. W. Prowse	Devonia Makarini (8217)
Selsey Wyandotte III.	do.	55215	14-8-34	5-5-38	89	21	2,130	6·47	137·94	Robinson Bros.	Brampton Great Boy (imp) (9137)
Leylands Red Rose	A.I.S.	21182	12-8-34	20-6-38	90	27	3,600	3·06	109·98	B. W. Prowse	Widgee Waa Record (848)
Muresk Pearl	Guernsey	6062	11-7-34	3-3-38	120	16	2,205	4·63	101·88	Muresk Agricultural College	Muresk Homestead (2075)
Crantock Golden Cream	Jersey	52397	27-6-34	24-1-38	150	4	1,410	5·87	82·74	Mrs. G. H. Burnside	Crantock Blondes Napoleon (8207)
COWS 4 YEARS AND UNDER 4½ YEARS—STANDARD 310 LBS. BUTTER-FAT.											
Tipperary Beauty II.	A.I.S.	18314	8-4-34	8-8-38	273	18	11,499	4·10	471·59	W. G. Burges	Blacklands Monarch's Commander (1877)
Lansdowne Joyce	Guernsey	4361	17-3-34	1-5-38	273	27	8,826	4·92	434·46	J. R. Giles	Koojan Ace's Advocate (2272)
					365	17	10,360	4·90	508·17		
Newstead Lovely 20th	A.I.S.	17585	19-2-34	13-3-38	273	30	10,530	4·12	433·03	W. G. Burges	Renown of Newstead (3077)

Westby Lupin III.	do.	18516	31–8–34	14–9–38	273	13	10,629	3·94	419·27	Bayley Bros.	Telyarup Duke (956)
Selsey Attraction	Jersey	55203	16–7–34	28–7–38	273	16	5,808	6·70	389·26	Robinson Bros.	Brampton Great Boy (imp.) (9317)
Koojan Ace's Daphne	Guernsey	5657	13–8–34	13–9–38	273	27·5	7,178	5·19	372·84	A. W. Padbury	Koojan Ace (2270)
Wooroloo Gold	A.I.S.	18632	31–1–34	9–5–38	273	19	8,517	4·13	351·68	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
Leylands Melba	do.	17170	1–9–33	26–12–37	273	12	7,746	4·41	341·41	D. Bevan & Sons	Widgee Waa Record (848)
Westby Polly II.	do.	15142	1–12–33	25–4–38	273	25	9,225	3·69	341·00	Bayley Bros.	Telyarup Duke (956)
Claremont Maggie Morrison 14th	do.	15965	14–9–33	21–12–37	273	15	8,790	3·84	337·95	Claremont Hospital for Insane	Claremont Herdsman (968)
Leylands Radium	do.	17176	15–3–34	4–5–38	273	15	8,025	3·94	315·94	Prowse Bros.	Widgee Waa Record (848)
Tipperary Dove	do.	18320	21–4–34	29–5–38	273	20	7,170	4·40	315·69	W. G. Burges	Blacklands Monarch's Commander (1877)
Westby Primrose	do.	18520	7–9–34	12–9–38	273	13	8,199	3·81	312·56	Bayley Bros.	Telyarup Duke (956)
Summerlea Dairymaid 16th	do.	18123	28–1–34	18–4–38	273	23	8,642	3·58	309·44	Dunkley Bros.	Summerlea Supreme (973)
Leylands Tiny	do.	17181	24–2–34	18–4–38	273	18	7,869	3·91	308·02	Prowse Bros.	Parkview Commodore (306)
Colmyn Daisy	Jersey	47679	25–10–33	2–3–38	273	19·5	5,444	5·58	303·84	C. H. Ironmonger	Colmyn Captain Mac (5855)
Lemon Grove Dora 8th	A.I.S.	17141	12–12–33	16–4–38	273	19	7,617	3·94	300·23	Prowse Bros.	Dan of Greyleigh (97)
Wooroloo Milkmaid 5th	do.	15339	2–1–34	14–1–38	273	24	7,452	4·02	299·91	E. T. Thatcher	Parkview Guardian (2557)
Greenmount Joyful Maid	Jersey	53052	13–3–34	19–3–38	273	10·5	5,357	5·48	293·65	A. J. B. Strempel	Bellefaire Bonaparte's Bonetienne (9224)
Summerlea Lady V.	A.I.S.	App. C.	23–5–33	15–6–38	273	16	7,871	3·55	279·36	Dunkley Bros.	Summerlea Togo (1527)
Claremont Mavis IV.	do.	15968	7–5–34	13–8–38	273	9	6,627	3·79	249·99	Claremont Hospital for Insane	Tipperary Virginia's Re-echo (970)
Moorlands Ione	Jersey		27–3–34	12–7–38	180	9	4,868	4·99	242·76	Estate Late P. Rose	Melrose Liberty (7973)
Capel Centenary Girl III.	do.	56707	3–3–34	1–5–38	210	8	3,915	5·84	228·75	B. W. Prowse	Capel Carnation's Pride (7988)
Wooroloo Joy	A.I.S.	15333	10–4–34	2–9–38	180	14	4,310	5·01	216·02	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
Tirano Violet	do.	22930	5–10–33	19–9–38	180	18·5	4,373	4·38	191·55	A. Della	Bryn-y-mor Charmer (266)
Capel Noraleda	Jersey	56709	7–3–34	1–7–38	120	28	3,758	4·63	171·57	B. W. Prowse	Capel Carnation's Pride (7988)
Tirano Betty	A.I.S.	22919	7–10–33	2–4–38	210	10	4,200	4·08	171·30	A. Della	Bryn-y-mor Charmer (266)
Drakesbrook Thelma	Guernsey	4146	26–4–34	8–8–38	120	23	3,255	4·60	149·70	J. Rae	Koojan Ace's Chancellor (2274)
COWS 4½ YEARS AND UNDER 5 YEARS—STANDARD 330 LBS. BUTTER-FAT.											
Greenmount Sweet Lass	Jersey	44204	14–7–33	13–3–38	273	24·5	8,572	5·76	494·03	A. J. B. Strempel	Bellefaire Bonaparte's Bonetienne (9244)
Koojan Golden Butterfly	Guernsey	4339	18–4–33	23–3–38	273	19	8,652	5·34	462·55	A. W. Padbury	Koojan Ace (2270)
Tabbagong Dove 11th	A.I.S.	12241	22–7–33	25–3–38	273	27	11,061	4·11	454·38	W. G. Burges	Parkview Reward II. (260)
Leylands Daphne	do.	12252	2–8–33	26–6–38	273	31	10848	4·02	436·51	B. W. Prowse	Widgee Waa Record (848)
Koojan Ace's Pixie	Guernsey	4336	11–4–33	24–3–38	273	22	8,376	5·12	429·30	A. W. Padbury	Homestead Ace (1631)
Claremont Star 12th	A.I.S.	9947	3–9–33	12–7–38	273	22·5	10,958	3·73	408·50	Claremont Hospital for Insane	Tipperary Daphne's Boy (449)
Lansdowne Bonny Blossom II.	Guernsey	4351	6–8–33	28–4–38	273	20	7,890	4·81	379·89	J. R. Giles	Koojan Ace's Advocate (2272)
Lemon Grove Fussy 6th	A.I.S.	17144	10–5–33	5–5–38	273	13·5	9,146	3·94	359·98	Prowse Bros	Alne Bank Lady's Gift (760)
Walgett Water Lily	Jersey	51066	28–8–33	24–4–38	273	13·5	8,501	4·18	355·76	C. J. Cunningham	Mokine Centenary (7595)
Lemon Grove Pride 8th	A.I.S.	17150	20–7–33	27–3–38	273	16	8,313	3·97	331·19	Prowse Bros.	Alne Bank Lady's Gift (760)
Brookdale Butterfly	Jersey	52028	29–6–33	20–4–38	273	15	6,645	4·96	329·90	B. P. Hack	Brookvale Noble Boy (7278)
Grass Vale Twylish Eve	do.	61960	17–10–33	22–6–38	240	11	6,210	5·27	327·21	R. H. Rose	Banyule Silvermine's Twylish (7600)
Lemon Grove Gracie 11th	A.I.S.	17148	10–8–33	24–4–38	273	15	7,950	4·09	324·99	Prowse Bros.	Greyleigh Archer (571)
Greyleigh Cinderella 28th	do.	16705	4–7–33	1–6–38	273	21	8,037	3·97	317·61	Prowse Bros.	Quenton of Greyleigh (1472)
Lemon Grove Gladys 10th	do.	17147	14–8–33	9–6–38	273	14	8,022	3·96	317·60	Prowse Bros.	Dan of Greyleigh (97)
Summerlea Swallow IV.	do.	18138	27–6–33	2–5–38	273	17·5	8,813	3·57	314·72	Dunkley Bros.	Kitchener of Summerlea (971)
Grass Vale Golden Cream 10th	Jersey	48535	7–10–33	1–7–38	273	11	5,478	5·73	313·76	R. H. Rose	Banyule Silvermine's Twylish (7600)
Walgett Joy	do.	51064	8–7–33	29–4–38	273	5·5	5,432	5·74	311·67	C. J. Cunningham	Mokine Centenary (7595)
Summerlea Lady IV.	A.I.S.	App. C.	15–5–33	16–4–38	273	12	7,956	3·77	301·10	Dunkley Bros.	Summerlea Supreme (973)

HERD TESTING—*continued.*

Name of Cow.	Breed.	Herd Book No.	Date of Birth.	Date of Calving.	No. of Days in Test.	Weight of Milk Last day of Test.	Weight of Milk for period	Average Test.	Weight of Butter-Fat for period.	Owner.	Sire.
COWS 4½ YEARS AND UNDER 5 YEARS—STANDARD 330 LBS. BUTTER-FAT—*continued.*											
						lb.	lb.	%	lb		
Leylands Model	do.	12254	12-8-33	4-7-38	210	28·5	7,680	3·79	291·60	B. W. Prowse	Widgee Waa Record (848)
Lemon Grove Buttercup 25th	do.	17136	25-7-33	16-7-38	273	11	6,888	4 02	277·13	Prowse Bros	Alne Bank Lady's Gift (760)
Tirano Rosie	do.	22928	16-6-33	16-2-38	273	6	6,408	4·00	255·68	A. Della	Bryn-y-mor Charmer (266)
Drakesbrook Pride	Guernsey	4145	16-10-33	26-4-38	210	20·5	4,905	4·47	219·45	J. Rae	Koojan Lord Barclay (1031)
Yanget Duchess II.	A.I.S.	15410	10-5-34	25-8-38	210	12	5,490	3·71	203·82	A. E. Grant	Sunrise of Parkview (1875)
Tirano Violet	do.	22930	5-10-33	19-9-38	180	18 5	4,373	4·38	191·55	A. Della	Bryn-y-mor Charmer (266)
Juadine Sparkle 8th	Jersey	48876	26-7-33	15-7-38	180	11·5	3,525	4·36	153 15	E Loynel	Juadine Sunshine (8212)
Leylands Princess	A.I.S.	12255	21-10-33	14-7-38	120	23	3,750	3·81	143 01	B. W. Prowse	Mayflower's Emblem of Hillview (955)
COWS 5 YEARS AND OVER—STANDARD 350 LBS. BUTTER-FAT.											
Moorlands Happy	Jersey	54219	3-4-33	5-5-38	273	10·5	8,762	6·01	526·43	Estate late P. Rose	Melrose Liberty (7973)
Lansdowne Morden Lady	Guernsey	3479	10-11-31	12-9-38	273	27·5	9,296	5·38	500·23	P. G. Hampshire	Koojan Golden Broadcaster (1632)
Koojan Lady Olive	do.	4340	11-2-33	25-3-38	273	24	9,537	5·14	490·61	A. W. Padbury	Homestead Ace (imp. U.S.A.) (1631)
Summerlea Empress VII.	A.I.S.	14127	20-8-32	9-5-38	273	26	10,773	4·30	463·49	Dunkley Bros.	Summerlea Searchlight (972)
New Park Sally 9th	do.	1873	30-4-29	18-5-38	273	18	12,774	3·79	459·38	W. G. Burges	Ruler of Greyleigh (1855)
Tabbagong Dove 8th	do.	7511	19-12-31	5-4-38	273	30	10,965	4·17	456·96	W. G. Burges	Parkview Reward II. (260)
Koojan Bonnie Evelyn	Guernsey	3899	7-4-32	27-8-38	273	23	8,064	5·47	441·52	A. W Padbury	Homestead Ace (imp. U.S.A.) (1631)
Denmark Golden Marie	do.	3873	26-4-32	1-8-38	273	18	7,824	5·59	437·03	Denmark Research Station	Koojan Golden Prosper (2283)
Koojan Ace's Jewel	do.	4333	19-2-33	13-3-38	273	17	8,556	5·09	435·86	A. W. Padbury	Homestead Ace (imp. U.S.A.) (1631)
Wooroloo Duchess II.	A.I.S.	15324	15-8-32	21-7-38	273	19	10,287	4·23	435·72	E. T. Thatcher	Triumph of Pine Creek (2515)
Blacklands Beauty 10th	do.	9279	2-4-32	27-8-38	273	18	10,472	4·12	431·03	W. G. Burges	Fussy's Monarch of Hillview (493)
Crantock Cream Lass	Jersey	43542	7-6-31	31-7-38	273	16	7,353	5·81	427 34	Mrs. G. H. Burnside	Crantock Starbright's Montrose (5945)
Crantock Starbright's Napoleonette	do.	52400	27-11-32	21-7-38	273	16·5	7,033	6 04	425·12	Mrs. G. H. Burnside	Crantock Blonde's Napoleon (8207)
Lottie III. of Marks Villa	A.I.S.	16484	10-11-28	5-8-38	273	15·5	10,382	4 06	421·57	B. W. Prowse	Marks Villa Dina's Lad
Westby Pearl	do.	15140	19-2-33	1-4-38	273	30·5	10,487	4·01	420·59	Bayley Bros.	Telyarup Duke (956)
Radyr Park Clarion Call	Jersey	45843	5-7-31	13-9-38	273	17·5	6,938	6 06	420·56	L. Temple	Melrose Clarion (6931)
Koojan Dame	Guernsey	1252	18-6-24	17-6-38	273	28	10,254	4·10	420·38	Denmark Research Station	Robin of Nundorah (417)
Coolup Gladys II.	Jersey	39353	1-5-30	9-9-38	273	27	8,661	4·83	418·29	B. W. Prowse	Fairy's Duke II. of Grassvale (7168)
Karridale Pride	Guernsey	1981	16-10-27	20-8-38	273	15	7,875	5·17	407·07	P. G. Hampshire	Minnamurra Oliver Twist (528)
Summerlea Red Rose III.	A.I.S.	14253	24-5-31	17-4-38	273	24	10,401	3·91	406 66	Dunkley Bros.	Summerlea Searchlight (972)
Beauna Vista Fairy V.	do.	1322	8-12-29	4-5-38	273	17	10,581	3·74	405·99	Prowse Bros.	Spearfelt of Alne Bank (1029)
Crantock Lady Bluebell	Jersey	34724	26-5-29	19-6-38	273	11	6,453	6 29	405 89	Mrs. G. H. Burnside	Crantock Starbright's Chief (5790)
Greenmount Starbright Marinora	do.	34841	31-5-30	30-7-38	273	16 5	7,100	5·69	404·58	A. J. B. Strempel	Werribee Starbright's King (2602)
Kudardup Pansy	Guernsey	2927	16-1-31	1-5-38	273	14	6,897	5·75	396 60	J R. Giles	Newry Golden Prince (977)
Summerlea Spangle 3rd.	A.I.S.	App. C.	15-10-30	25-5-38	273	16·5	10,493	3·71	389·55	Dunkley Bros.	Victor of Telyarup (2498)
Newstead Daisy 12th	do.	12955	28-5-30	27-1-38	273	25	9,165	4·24	388·37	W. G. Burges	Superb of Newstead (2911)
Denmark Rosebud	Guernsey	3876	14-3-32	2-5-38	273	19	7.077	5·33	387·67	Denmark Research Station	Wollongbar McQuarrie
Summerlea Sweet Doris II.	A.I.S.	App. D.	18-3-28	5-5-38	273	26	11,943	3·24	386·63	Dunkley Bros.	Musket of Claremont (Vol. 8, found)

Newry Lady Freda... ...	Guernsey	2719	13–9–28	12–9–38	273	10	6,945	5·56	386·11	P. G. Hampshire ..	Koojan Mac (596)
Crantock Lady Primrose ...	Jersey	52398	10–6–31	20–5–38	273	17	6,524	5·78	376·96	Mrs. G. H. Burnside ..	Crantock Starbright's Montrose (5945)
Westly Lupin	A.I.S.	15138	28–3–32	4–8–38	273	18	10,494	3·58	376·09	Bayley Bros. ..	Telyarup Duke (956)
Crantock Cream Star ..	Jersey	34723	14–8–28	7–7–38	273	12	6,141	6·09	373·93	Mrs. G. H. Burnside ...	Crantock Starbright's Chief (5790)
Wyuna Lady Dawn .	Guernsey	2472	12–11–29	16–6–38	273	16	7,428	4·95	367·85	Denmark Research Station	Nundorah Prosper (664)
Karridale Lady Biddy .	do.	2332	29–5–28	1–7–38	273	17	8,301	4·43	367·43	J. R. Giles	Minnamurra Oliver Twist (528)
Illawah Limerick Lass II. ..	A.I.S.	5016	14–9–29	23–3–38	273	23	8,144	4·50	366·73	Prowse Bros. ..	Sentinel of Greyleigh (1647)
Grangelea Pretty Primrose ...	Jersey	33038	31–10–29	25–3–38	210	26	6,075	5·99	363·96	Sabina Vale Stud Farm	Banyule Airo (5751)
Muresk Dessie	Guernsey	4722	20–4–33	9–7–38	273	16	7,435	4·88	363·04	Muresk Agricultural College	Triumph of Wollongbar (513)
Denmark Orangebud ..	do.	4123	9–8–32	18–10–37	273	26	8,748	4·15	363·01	Denmark Research Station	Koojan Golden Prosper (2283)
Illawah Le III.	A.I.S.	11797	15–2–33	28–3–38	273	24	9,912	3·58	356·66	D. Bevan & Sons ..	Illawah Veteran's Hope (822)
Grass Vale Golden Cream 7th	Jersey	44182	19–7–32	9–6–38	273	10	6,300	5·63	354·92	R. H. Rose .	Banyule Silvermine's Twylish (7600)
Westby Polly	A.I.S.	15141	21–5–32	25–1–38	273	35	9,510	3·71	352·71	Bayley Bros. ..	Telyarup Duke (956)
Moorlands Dot	Jersey	31236	16–5–29	5–7–38	273	11	7,278	4·84	352·40	L. Temple ..	Melrose Romeo (5861)
Denmark Golden Dawn	Guernsey	4118	9–1–33	16–5–38	273	13	5,889	5·93	349·26	Denmark Research Station	Koojan Golden Prosper (2283)
Crantock Lady Buttercup ..	Jersey	39439	21–5–30	20–9–38	273	20	6,030	5·77	347·89	Mrs. G. H. Burnside .	Crantock Starbright's Montrose (5945)
Brookfields Lady Faith .	Guernsey	4062	19–6–32	3–1–38	273	24·5	6,722	5·11	343·46	P. G. Hampshire	Koojan Lord Barklay (1031)
					365	22·5	8,981	5·26	472·97		
Clarendon Eyre Tangerine VI	Jersey	43396	4–2–32	7–6–38	273	13·5	6,791	5·03	341·90	B. P. Hack	Rochette's Golden (imp.) (7962)
Lansdowne Dorothy ..	Guernsey	4359	27–7–33	25–7–38	273	18	7,644	4·47	341·85	J. R. Giles	Koojan Ace's Advocate (2272)
Denmark Prosper's Rosa ..	do.	4127	27–12–32	13–5–38	273	20	6,420	5·32	341·62	Denmark Research Station	Koojan Golden Prosper (2283)
Grantham Easter Fairy .	Jersey	34825	18–9–31	9–6–38	240	18·5	6,045	5·62	339·60	J. A. Sears	Greenmount Black Prince (6511)
Summerlea Milkmaid III. ..	A.I.S.	App. D.	19–3–28	17–4–38	273	14	9,702	3·47	337·18	Dunkley Bros. .	Musket of Claremont (Vol. 8, found)
Swanlea Lovely 7th .	do.	4284	12–2–31	18–4–38	273	27	9,471	3·55	336·54	A. E. Grant .	Headlight of Parkview (1406)
Westby Ulery	do.	15143	15–6–33	11–8–38	273	5	9,735	3·44	335·22	Bayley Bros.	Telyarup Duke (956)
Beauna Vista Tiny 18th .	do.	4221	24–6–30	10–6–38	273	20	8,610	3·86	332·96	Prowse Bros.	Spearfelt of Alne Bank (1029)
Koojan Daffodil .	Guernsey	2231	4–10–28	11–9–38	273	14·5	6,389	5·04	322·01	Misses Rutherford	Koojan Golden Governor (595)
Radyr Park Clarion Call	Jersey	45843	5–7–31	21–10–37	273	11·5	5,465	5·88	321·22	L. Temple .	Melrose Clarion (6931)
Longridge Blanche	A.I.S.	7664	12–4–32	19–12–37	273	24	7,842	4·09	321·00	R. Bee & Sons ..	Minathorpe Kitchener (434)
Blacklands Pretty Maid VI.	do.	9376	25–2–32	28–10–37	210	22	8,408	3·82	320·87	A. E. Grant	Orama of Blacklands (1905)
The Wold Starbright Grey II.	Jersey	46430	17–4–33	23–6–38	240	14	7,735	4·07	315·03	L. C. Field .	Lonswood Lord Grey (7291)
Radyr Park Laddie's Estrellita	do.	45846	16–7–32	12–6–38	273	12	5,241	5·97	312·78	L. Temple .. .	Graceful Lad of Greenmount (7292)
Glanavon Sunbeam III. .	A.I.S.	10929	16–10–32	20–9–38	273	19	7,617	4·10	312·65	D. Bevan & Sons	Glanavon Nimrod (437)
Walgett Handsome Girl I. .	Jersey	42402	1–12–31	21–4–38	273	5·5	5,882	5·30	311·85	C. J. Cunningham	Burekup Campanile's Duke (7287)
Grass Vale Lady Fowler 17th	do.	48536	6–5–33	27–6–38	240	12·5	5,325	5·79	308·34	R. H. Rose	Banyule Silvermine's Twylish (7600)
Numbawarra Silky III. ...	A.I.S.	17626	28–8–32	2–5–38	273	17	7,941	3·87	307·01	Prowse Bros.	Jellicoe of Fairfield (1136)
Wingeewah Kate III. .	do.	1535	20–3–29	4–4–38	273	23	7,944	3·80	302·10	A. Della . .	Daphne's Defiance of Hillview (Vol. 8, found)
Blacklands Daphne 7th .	do.	9291	18–10–32	15–3–38	273	19	8,255	3·64	300·86	A. E. Grant .	Fussy's Monarch of Hillview (493)
The Wold Northwood Grey	Jersey	42214	15–5–32	15–4–38	273	11·5	5,390	5·58	300·57	L. C. Field	Lonswood Lord Grey (7291)
Wingeewah Winnie 7th .	A.I.S.	4395	20–3–30	24–6–38	273	23	7,250	4·13	299·57	A. E. Grant	Daphne's Defiance of Hillview (Vol. 8, found)
Hillview Fussy 34th .	do.	4496	3–9–30	31–10–37	273	8	9,099	3·28	299·27	A. E. Grant ..	Limelight of Hillview (954)
Minnamurra Currency Lass	Guernsey	2606	27–10–29	18–3–38	273	15	5,925	5·03	297·99	Muresk Agricultural College	Caramana Favour (652)

HERD TESTING—*continued.*

Name of Cow.	Breed.	Herd Book No.	Date of Birth.	Date of Calving.	No. of Days in Test.	Weight of Milk Last day of Test.	Weight of Milk for period	Average Test.	Weight of Butter-Fat for period.	Owner.	Sire.
COWS 5 YEARS AND OVER—STANDARD 350 LBS. BUTTER-FAT—*continued.*											
						lb.	lb.	%	lb.		
Sabina Vale Ruby's Lass ...	Jersey	50538	5–4–32	10–3–38	240	18·5	5,310	5·57	296·07	Sabina Vale Stud Farm	Clarendon Eyre Ruby's Beau (7963)
Walgett Handsome Girl 3rd	do.	51063	12–11–32	21–4–38	273	7	5,616	5·22	293·28	C. J. Cunningham	Mokine Centenary (7595)
Minnamurra Eleanor ...	Guernsey	2607	13–8–29	26–7–38	273	12	6,516	4·48	292·27	Muresk Agricultural College	Caramana Favour (652)
Denmark Rosa III.	do.	2523	5–4–29	2–10–38	210	15	6,030	4·78	288·48	Denmark Research Station	Wollongbar Reformer (538)
Moorlands Glide	Jersey	45237	5–8–32	12–6–38	210	10·5	5,310	5·42	287·94	Estate late P. Rose	Melrose Clarion (6931)
The Wold Daisy Grey II.	do.	46428	28–3–33	29–5–38	240	14	5,663	5·07	286·98	L. C. Field	Lonswood Lord Grey (7291)
Blacklands Red Queen 8th	A.I.S.	9386	16–10–32	11–6–38	240	12	7,620	3·73	284·16	A. E. Grant	Orama of Blacklands (1905)
Tabbagong Beauty 19th	do.	7502	20–12–31	18–5–38	273	5	7,103	3·91	278·10	A. E. Grant	Parkview Reward II. (260)
Swanlea Radium 8th	do.	4990	17–7–31	10–5–38	273	12	7,266	3·79	275·66	Prowse Bros.	Headlight of Parkview (1406)
Beanna Vista Jocks Tiny ..	do.	9075	25–9–32	11–4–38	240	15	7,470	3·68	275·37	D. Bevan & Sons	Beauna Vista Jock (212)
Walgett Handsome Girl II.	Jersey	51062	12–11–32	2–5–38	273	6	5,253	5·09	267·80	C. J. Cunningham	Mokine Centenary (7595)
Walgett Duchess	do.	42400	20–8–31	21–5–38	273	5	5,100	5·21	266·04	C. J. Cunningham	Burekup Campanile's Duke (7287)
Blacklands Graceful 7th	A.I.S.	9318	24–7–32	23–7–38	273	12	7,011	3·37	263·26	A. E. Grant	Orama of Blacklands (1905)
Wingeewah Silver III.	do.	1547	4–10–28	25–7–38	240	15·5	5,910	4·33	256·11	A. Della	Karawarra Werri (2759)
Blacklands Florrie 13th	do.	9306	3–12–31	3–5–38	240	20	5,745	4·43	254·43	A. E. Grant	Orama of Blacklands (1905)
Blacklands Daphne 6th ..	do.	9290	2–11–32	29–7–38	273	9	6,897	3·56	245·88	A. E. Grant	Fussy's Monarch of Hillview (493)
Tirano Princess	do.	7677	22–12–30	19–9–38	180	17	5,085	4·75	241·53	A. Della	Pine Creek Banker (450)
Fairfield Victory's Actress ..	do.	10721	25–9–32	27–5–38	273	16	7,285	3·31	241·24	D. Bevan & Sons ...	Daphne's Victory of Hillview (1652)
Crantock Lady Buttercup	Jersey	39439	21–5–30	22–10–37	273	8	4,521	5·26	237·78	Mrs. G. H. Burnside	Crantocks Starbright's Montrose (5945)
Wingeewah Melba	A.I.S.	6732	22–4–31	15–2–38	210	20	6,150	3·84	236·01	A. Della	Regent of the Hill (3038)
Denmark Rosa III. ...	Guernsey	2523	5–4–29	31–10–37	210	8	4,875	4·77	232·53	Denmark Research Station	Wollongbar Reformer (538)
Yanget Pansy II.	A.I.S.	8337	10–8–31	24–5–38	273	13	4,989	4·58	228·56	Prowse Bros.	Yanget Pet's Re-echo (452)
Moorlands Granny	Jersey	.	24–6–32	27–3–38	273	12	4,184	5·46	228·41	E. Loynel	Melrose Clarion (6931)
Blacklands Sadie V.	A.I.S.	9391	26–9–32	26–2–38	240	19	5,730	3·92	224·82	D. Bevan & Sons	Blacklands Major (369)
Badyr Park Dorothy II. ...	Jersey	45845	24–7–32	24–10–37	240	6·5	4,463	5·02	223·95	L. Temple	Graceful Lad of Greenmount (7292)
Koojan Bo-peep	Guernsey	3542	26–2–31	22–2–39	90	44	3,870	5·70	220·86	A. W. Padbury	Homestead Ace (imp. U.S.A.) (1631)
Tirano Primrose ..	A.I.S.	22927	25–3–32	14–2–38	273	4·5	4,874	4·36	212·81	A. Della	Bryn-y-mor Charmer (266)
Sabina Vale Silvermine ...	Jersey	50539	29–3–32	18–5–38	180	23	4,455	4·60	205·74	Sabina Vale Stud Farm	Banyule Lord Silvair (5752)
Koojan Ace's Mignonette ...	Guernsey	3898	23–4–32	10–9–38	120	28	3,960	5·19	205·44	A. W. Padbury	Homestead Ace (imp. U.S.A.) (1631)
Sabina Vale Blossom	Jersey	50536	28–11–32	21–5–38	150	20	3,930	4·90	195·33	Sabina Vale Stud Farm	Glen Iris Matilda's Lord (9491)
Tipperary Daphne	A.I.S.	5114	5–10–30	8–5–38	180	15	5,205	3·66	190·29	B. W. Prowse	Melba's Re-echo of Darbalara (252)
Karridale Patsy ...	Guernsey	3593	4–1–30	28–4–38	210	14	3,690	4·95	182·67	J. Rae	Minnamurra Betty's Prince (524)
Drakesbrook Golden Kitty ..	do.	4143	26–2–33	2–7–38	150	20·5	3,675	4·75	174·80	J. Rae	Koojan Lord Barklay (1031)
Crantock Blonde Susanette	Jersey	56951	28–10–32	24–11–37	210	13·5	3,180	5·31	168·95	Mrs. G. H. Burnside	Crantock Blonde's Napoleon (8207)
Cookalabai Tulip ...	Guernsey	3773	12–10–30	24–4–38	210	12	4,028	4·19	168·94	J. Rae	Cookalabai Pride II. (2456)
Blacklands Myrtle 8th	A.I.S.	9369	3–9–32	5–5–38	120	24	3,848	4·02	154·66	A. E. Grant ..	Parkview Limelight (370)
Clarendon Eyre Betty	Jersey	39244	28–4–28	5–7–38	120	29·5	3,750	4·10	153·66	Sabina Vale Stud Farm	Clarendon Eyre Eminent's Achievement (4154)
Crantock Blonde Susanette	do.	56951	28–10–32	25–1–39	120	10·5	2,430	5·81	141·26	Mrs. G. H. Burnside .	Crantock Blonde's Napoleon (520)
Sabina Vale Countess	do.	55175	27–4–32	21–7–38	90	23·5	2,505	5·60	139·50	Sabina Vale Stud Farm	Bellefaire Seaborn Successor (imp.) (6824)

Fairfield Shirley	A.I.S	6476	3-8-31	12-7-38	120	29	3,870	3·59	139·23	B. W. Prowse	Kinsman 3rd of Greyleigh
Moorlands Gladiola	Jersey	54218	16-6-32	20-9-38	120	12 5	3,000	4 37	131 10	E Loynel	Melrose Liberty (7973)
Nooka Red Rose	do.	49858	28-12-32	6-10-38	120	16 5	2,970	4·12	122 34	E. Loynel	Nooka Carnation's King (8214)
Drakesbrook Golden Lassie	Guernsey	3591	13-9-31	3-9-38	90	18	2.100	5 33	112 02	J. Rae	Wollongbar Associate (531)
Banyule Silvermine 66th	Jersey	28847	10-9-29	26-8-38	60	37	2,370	4·60	108·54	Sabina Vale Stud Farm	Milkmaid's Chief of Banyule (1412)
Sabina Vale Lotus	do.	46111	16-1-32	1-8-38	90	26	2.400	4·40	106 17	Sabina Vale Stud Farm	Banyule Airo (5751)
Koojan Bluebell	Guernsey	1674	9-8-26	15-8-38	60	36	2,160	4 91	106·08	J. Rae	Robin of Nundorah (417)
Juadine Sparkle 7th	Jersey	44521	11-7-33	3-10-38	120	13·5	2,760	3 47	95·79	E. Loynel	Juadine Sunshine (8212)
Moorlands Genuine	do.	63180	2-11-32	2-4-38	180	6·5	1,658	5·63	93·27	E. Loynel	Melrose Clarion (6931)
Banyule Velveteen 12th	do.	24474	11-9-27	25-8-38	60	30 5	1,965	4·50	88 77	Sabina Vale Stud Farm	Wotton Airman (imp.) (2716)
Koojan Dolly	Guernsey	1254	18-6-25	20-7-38	90	30	2,400	3 67	88·02	J. Rae	Robin of Nundorah (417)
Sabina Vale Silvermine III.	Jersey	50540	25-5-33	1-9-38	60	28 5	1.740	4·80	86·52	Sabina Vale Stud Farm	Glen Iris Matilda's Lord (9481)
Moorlands Glee	do.	58545	22-8-32	2-5-38	90	7	936	6 05	56·63	E. Loynel	Melrose Clarion (6931)
Sabina Vale Pansy ..	do.	55176	23-11-32	7-10-38	30	32 5	975	5·35	52·50	Sabina Vale Stud Farm	Glen Iris Matilda's Lord (9491)
Summerlea Milkmaid XI .	A I.S	App. C	6-9-32	8-5-38	30	41	1,230	3 71	45 66	Dunkley Bros.	Summerlea Searchlight (972)
Drakesbrook Janet .	Guernsey	4144	2-11-32	24-5-38	30	14	420	4 46	18 72	J Rae	Woodstock Emperor (2119)

BREEDING TABLES.

Time of Service.	Mares 340 days.	Cows 283 days.	Ewes 150 days.	Sows 112 days.	Bitches 63 days.
January 1	December 6	October 10	May 30	April 22	March 4
,, 8	,, 13	,, 17	June 6	,, 29	,, 11
,, 15	,, 20	,, 24	,, 13	May 6	,, 18
,, 22	,, 27	,, 31	,, 20	,, 13	,, 25
,, 29	January 3	November 7	,, 27	,, 20	April 1
February 5	,, 10	,, 14	July 4	,, 27	,, 8
,, 12	,, 17	,, 21	,, 11	June 3	,, 15
,, 19	,, 24	,, 28	,, 18	,, 10	,, 22
,, 26	,, 31	December 5	,, 25	,, 17	,, 29
March 5	February 7	,, 12	August 1	,, 24	May 6
,, 12	,, 14	,, 19	,, 8	July 1	,, 13
,, 19	,, 21	,, 26	,, 15	,, 8	,, 20
,, 26	,, 28	January 2	,, 22	,, 15	,, 27
April 2	March 7	,, 9	,, 29	,, 22	June 3
,, 9	,, 14	,, 16	September 5	,, 29	,, 10
,, 16	,, 21	,, 23	,, 12	August 5	,, 17
,, 23	,, 28	,, 30	,, 19	,, 12	,, 24
,, 30	April 4	February 6	,, 26	,, 19	July 1
May 7	,, 11	,, 13	October 3	,, 26	,, 8
,, 14	,, 18	,, 20	,, 10	September 2	,, 15
,, 21	,, 25	,, 27	,, 17	,, 9	,, 22
,, 28	May 2	March 6	,, 24	,, 16	,, 29
June 4	,, 9	,, 13	,, 31	,, 23	August 5
,, 11	,, 16	,, 20	November 7	,, 30	,, 12
,, 18	,, 23	,, 27	,, 14	October 7	,, 19
,, 25	,, 30	April 3	,, 21	,, 14	,, 26
July 2	June 6	,, 10	,, 28	,, 21	September 2
,, 9	,, 13	,, 17	December 5	,, 28	,, 9
,, 16	,, 20	,, 24	,, 12	November 4	,, 16
,, 23	,, 27	May 1	,, 19	,, 11	,, 23
,, 30	July 4	,, 8	,, 26	,, 18	,, 30
August 6	,, 11	,, 15	January 2	,, 25	October 7
,, 13	,, 18	,, 22	,, 9	December 2	,, 14
,, 20	,, 25	,, 29	,, 16	,, 9	,, 21
,, 27	August 1	June 5	,, 23	,, 16	,, 28
September 3	,, 8	,, 12	,, 30	,, 23	November 4
,, 10	,, 15	,, 19	February 6	,, 30	,, 11
,, 17	,, 22	,, 26	,, 13	January 6	,, 18
,, 24	,, 29	July 3	,, 20	,, 13	,, 25
October 1	September 5	,, 10	,, 27	,, 20	December 2
,, 8	,, 12	,, 17	March 6	,, 27	,, 9
,, 15	,, 19	,, 24	,, 13	February 3	,, 16
,, 22	,, 26	,, 31	,, 20	,, 10	,, 23
,, 29	October 3	August 7	,, 27	,, 17	,, 30
November 5	,, 10	,, 14	April 3	,, 24	January 6
,, 12	,, 17	,, 21	,, 10	March 3	,, 13
,, 19	,, 24	,, 28	,, 17	,, 10	,, 20
,, 26	,, 31	September 4	,, 24	,, 17	,, 27
December 3	November 7	,, 11	May 1	,, 24	February 3
,, 10	,, 14	,, 18	,, 8	,, 31	,, 10
,, 17	,, 21	,, 25	,, 15	April 7	,, 17
,, 24	,, 28	October 2	,, 22	,, 14	,, 24
,, 31	December 5	,, 9	,, 29	,, 21	March 3

WESTERN AUSTRALIAN EXPORT LAMBS, 1938.

F. L. SHIER and R. P. ROBERTS.

A study was made of the origins and quality of the lambs treated for export in Western Australia during the 1937 season and reported in a previous issue of this Journal.*

In the following paper a similar analysis is made of the lambs treated in 1938.

In Table I. are shown the numbers of lambs exported since the resumption of this trade in 1930, together with the average f.o.b. prices.

TABLE 1.

NUMBER OF LAMBS EXPORTED FROM WESTERN AUSTRALIA, 1930-1938, TOGETHER WITH AVERAGE PRICES PER HEAD.

Year.	No. of Carcases.	F.O.B. Value per Carcase (excluding Skin, By-products, etc.). s. d.
1930	22,826	...
1931	63,189	16 2
1932	10,527	13 10
1933	39,513	11 11
1934	113,454	17 5
1935	168,201	16 4
1936	143,949	17 0
1937	269,260	17 4
1938	363,645	17 6

The total of 363,645 exported in 1938 was the highest yet recorded, exceeding that of 1937 by approximately 95,000 or 35 per cent., and is indicative of the rapid expansion of the industry which is occurring in Western Australia.

During the 1938 season, 378,507 lambs, including approximately 3,000 which were graded as "summer" lambs and included in this study, were treated for export at the Robbs Jetty Works at Fremantle (338,188) and the Albany Freezing Works (40,319). Of this total it was possible to obtain the districts of origin and grading particulars for 315,477 lambs (275,158 from Robbs and 40,319 from Albany) which were forwarded direct from the country to the export works. In addition to these, information concerning only the district of origin was obtainable for a further 56,245 which were forwarded to the works at Robbs Jetty by exporters from the Midland Junction markets, but as they lost their geographical identity when passing through the sale yards, the available grading particulars were of no value for this survey. No information regarding either district of origin or grading was available for the balance (6,785) (1.9 per cent.). It was, therefore, possible to obtain districts of origin for 371-722 lambs treated out of a total of 378,507 (98 per cent.), and grading particulars of 315,477 (83 per cent.).

The distribution of the 378,507 is shown diagramatically in Figure 1 Figure 2 is a key map of the south-west portion of Western Australia showing the statistical districts, railways and the seven main subdivisions of the agricultural districts (heavy broken line) made for the purposes of these analyses.

All the lamb producing areas to the east of the 15in. rainfall line are grouped together and referred to as the Eastern districts. To the west of this line Mingenew and other road board districts northwards are referred to as the Northern districts. Three Springs, Carnamah, Moora, Dandarragan and the northern portion of Victoria Plains constitute the Midlands. The Central district includes Gingin, Chittering, Swan, Toodyay, Northam, York, Beverley, Brookton and those parts of

*Journal of the Department of Agriculture of Western Australia, December, 1938, pages 474-487.

Goomalling, Meckering and Quairading to the west of the 15in. isohyet. The South West consists of all road board districts to the west of the 25in. rainfall line south of Perth and extending east as far as the east boundaries of the Upper Blackwood and Manjimup districts. The Great Southern district lies between the 15in. and

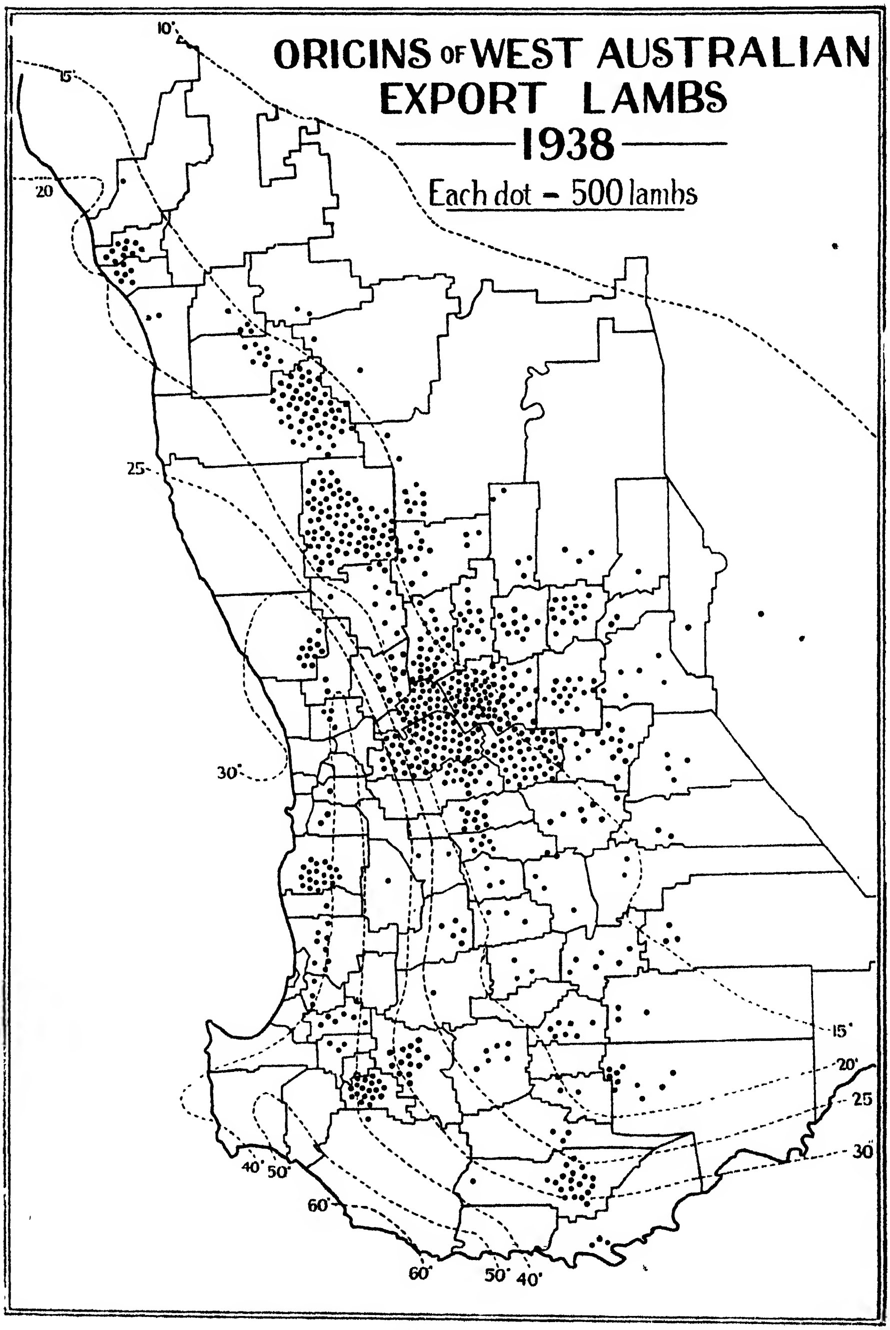


Fig. 1.

25in. rainfall line south of Brookton and Quairading and north of Katanning and Kent. The Kojonup, Cranbrook, Plantagenet, Denmark, Albany, Gnowangerup, Tambellup, Broomehill, Katanning and Kent districts constitute the Lower Great Southern.

The number of lambs from each of these subdivisions is shown in Table 2 in comparison with the figures for 1937.

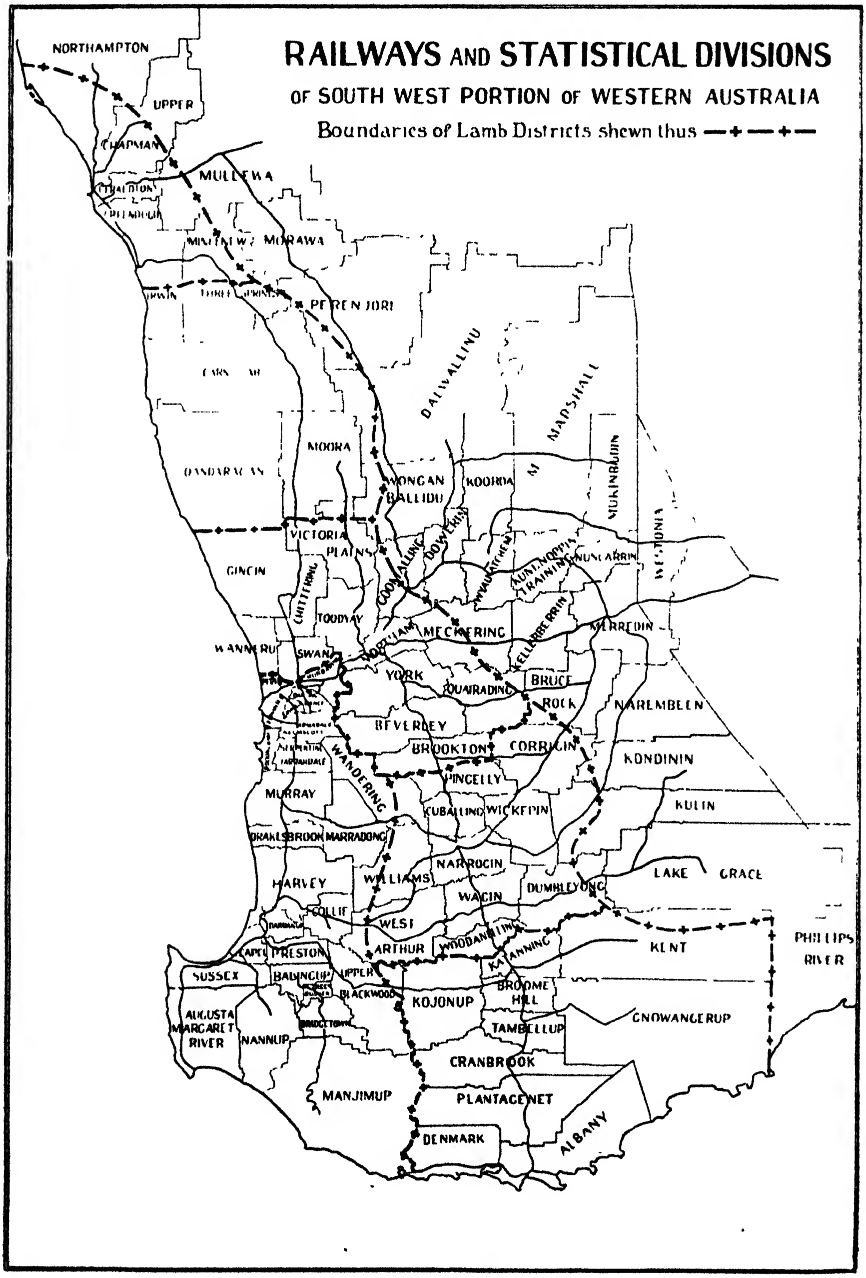


Fig. 2.

TABLE 2.

PERCENTAGE CONTRIBUTION OF DISTRICTS FOR 1937 AND 1938.

—	Lambs for which complete grading information available.		Lambs for which only partial information available.		Total Lambs Treated.				Increase or decrease for 1938.
	1937 (209,357).	1938 (315,477).	1937 (69,579).	1938 (56,245).	1937.		1938.		
	%	%	%	%	%	No.	%	No.	%
Northern	3	3	2	1	3	8,180*	3	11,428	+40
Midlands	22	20	11	10	19	53,218	19	69,245	+30
Central	34	34	45	40	37	102,404	35	128,442	+25
Eastern	11	17	32	40	16	45,327	20	75,537	+67
South-West	18	12	3	3	15	41.024	11	39,504	— 4
Great Southern	5	5	6	5	5	14,137	5	19,855	+40
Lower Great Southern	7	9	1	1	5	14,646	7	27,711	+ 9
	100	100	100	100	100	278,936	100	371,722	+33

* Incorrectly reported as 5,207 in previous paper.

The chief feature of the table is the increased percentage of lambs from the Eastern districts. The figures for this subdivision showed a 67 per cent. increase over those of the previous year and the contribution to the State's total rose from 16 per cent. to 20 per cent. Lambs from the South-West, on the other hand, decreased slightly in numbers, and the percentage contribution to the total declined from 15 to 11 per cent.

The yearly grading figures for the State are given in Table 3 and in Table 4 the grading particulars for 1937 and 1938 according to the district of origin of the lambs.

TABLE 3.
GRADING OF WEST AUSTRALIAN EXPORT LAMBS, 1930–38.

Year.	Firsts.	Seconds.	Thirds.	Rejects
1930	33·0	36·7	20·0	10·3
1931	34·5	44·4	18·0	3·1
1932	51·7	26·3	17·6	4·4
1933	37·8	22·1	37·2	2·9
1934	51.8	24.6	21.1	2.5
1935	38.3	38.4	21.5	1.8
1936	26.9	38.9	30.9	3.3
1937	32.0	37.2	27.7	3.1
1938	36.9	32.4	26.8	3.9

TABLE 4.
GRADINGS OF WESTERN AUSTRALIAN EXPORT LAMBS ACCORDING TO DISTRICT OF ORIGIN, 1937 AND 1938.

District.	Firsts.		Seconds.		Thirds.		Rejects.	
	1937.	1938.	1937.	1938.	1937.	1938.	1937.	1938.
Northern	17.9	21.5	41.4	33.7	36.8	38.1	3.9	6.7
Midlands	40.5	45.1	33.2	29.1	23.8	22.2	2.5	3.6
Central	28.7	43.2	37.7	31.3	30.7	22.4	2.9	3.1
Eastern	27.3	35.6	38.7	32.0	30.2	27.3	3.8	5.1
South-West	49.2	43.5	32.9	29.1	15.1	24.5	2.8	2.9
Great Southern	34.3	27.6	38.4	38.1	23.3	30.4	4.0	3.9
Lower Great Southern ...	54.4	22.1	34.9	40.9	8.8	32.1	1.9	4.9
State	32.0	36.9	37.2	32.4	27.7	26.8	3.1	3.9

The grading returns are largely a reflection of the seasonal conditions. The improved figures for 1938 as compared with 1937 are mainly due to the better incidence of the seasonal rains (although much below normal), resulting in improved pasture growth in the Central district, whose contribution of 35 per cent. of the total lambs treated had 43.2 per cent. first-grade carcases compared with 28.7 per cent. in 1937.

In the Lower Great Southern district there was a marked fall in the grading, the percentage of first-grade dropping from 54.4 in 1937 to 22.1 in 1938. This fall was probably influenced to a large extent by the system of buying that operated in 1938 whereby prices were offered for lambs delivered by a certain date. This encouraged early delivery, frequently before the lambs had attained a satisfactory "finish." The bulk of the rejects at Albany, for example, were for "below export

TABLE 5.

CONTRIBUTIONS OF DISTRICTS TO LAMBS RECEIVED AT WORKS DURING HALF-MONTHLY PERIODS, 1938.

Subdivision.	Per cent. for—										
	1st–15th July.	16th–31st July.	1st–15th August.	16th–31st August.	1st–15th September.	16th–30th September.	1st–15th October.	16th–31st October.	1st–15th November.	16th–30th November.	1st–15th December.
Northern	...	...	...	1	5	6	3	3	2	1	...
Midlands	63	57	49	36	29	25	18	9	...	1	6
Central	17	37	27	38	35	36	34	37	32	10	...
Eastern	...	6	18	21	18	18	19	18	11	...	...
South-West	..	...	...	..	2	2	15	17	32	52	44
Great Southern ...	...	...	4	2	4	6	5	6	8	3	2
Lower Great Southern	20	...	2	2	7	7	6	10	15	33	48
Total (per cent.) ...	100	100	100	100	100	100	100	100	100	100	100
Total (No.) (315,477)	512	2,525	6,676	24,284	40,301	87.462	67,336	48.372	20,053	15,796	2,160

standard." In general, the better prices offered for the early lambs have encouraged early mating in these areas resulting in lambs being produced during the cold, wet months and before the usual flush of feed. Whether this is the best practice is an involved question and not suitable for discussion in this paper, but it is felt that mating in these districts should be later than it is at present. This would ensure better grading figures over a period of years.

Although production is small and the industry is as yet in its infancy in the Northern district, the grading returns for 1938 were again decidedly below the average. Poor seasonal conditions were undoubtedly the main cause.

In the other districts there were only slight differences between the returns for the two years.

The manner in which each district contributed to the total lambs treated in the half-monthly periods throughout the killing season is indicated in Table 5.

In the accompanying series of graphs (Figures 3 to 9) are shown for each district:—

(1) The total numbers of lambs received for export at the freezing works during the half-monthly periods (in solid black), and

(2) The percentage grading for each of these periods (hachuring).

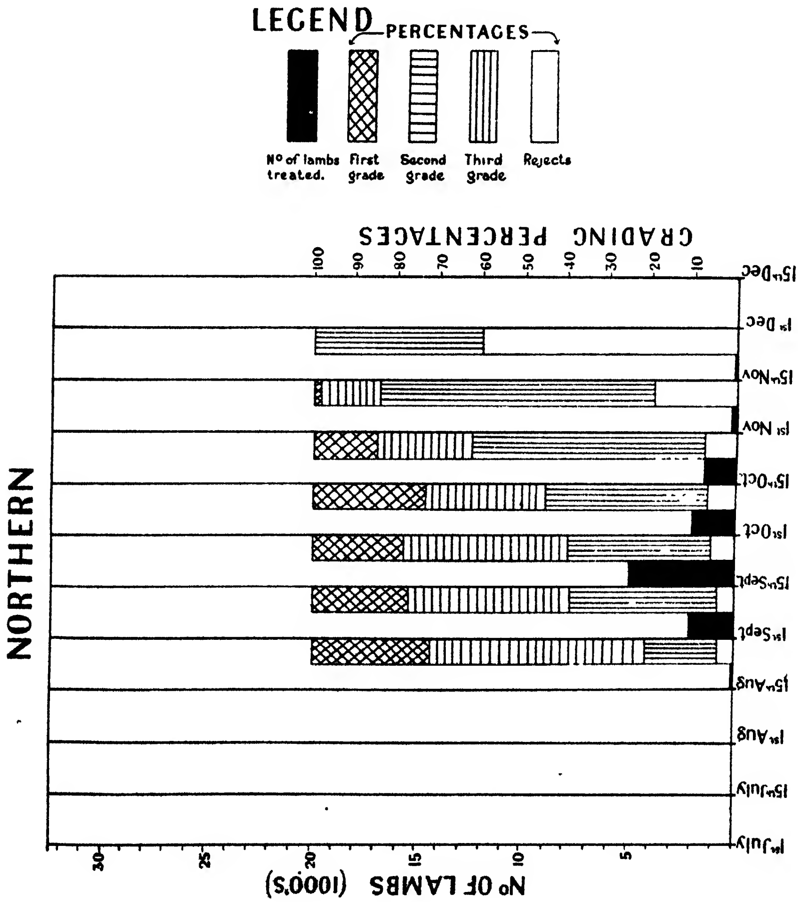


Fig. 3.

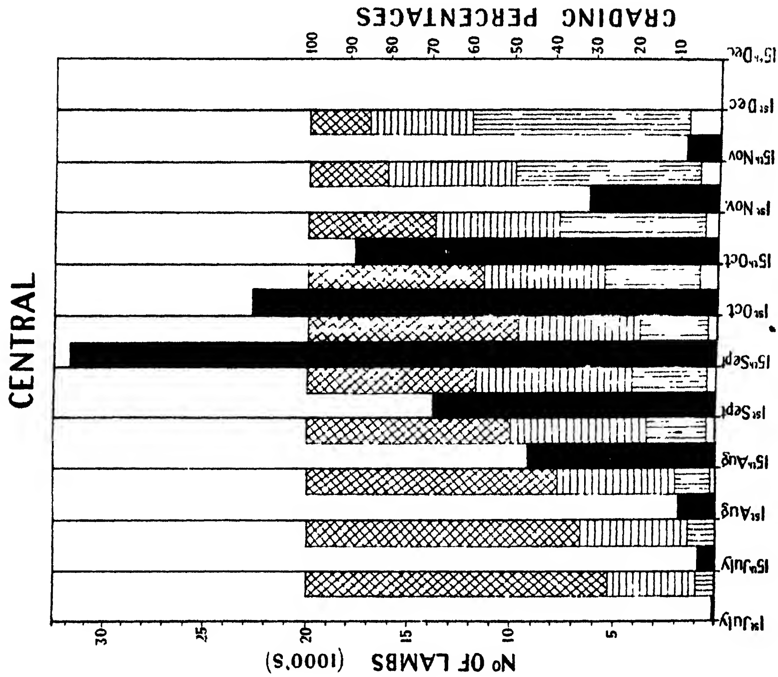

CENTRAL
GRADING PERCENTAGES
100 90 80 70 60 50 40 30 20 10
No OF LAMBS (1000's)
30 25 20 15 10 5
1st July
15th July
1st Aug
15th Aug
1st Sept
15th Sept
1st Oct
15th Oct
1st Nov
15th Nov
1st Dec
15th Dec

Fig. 5.

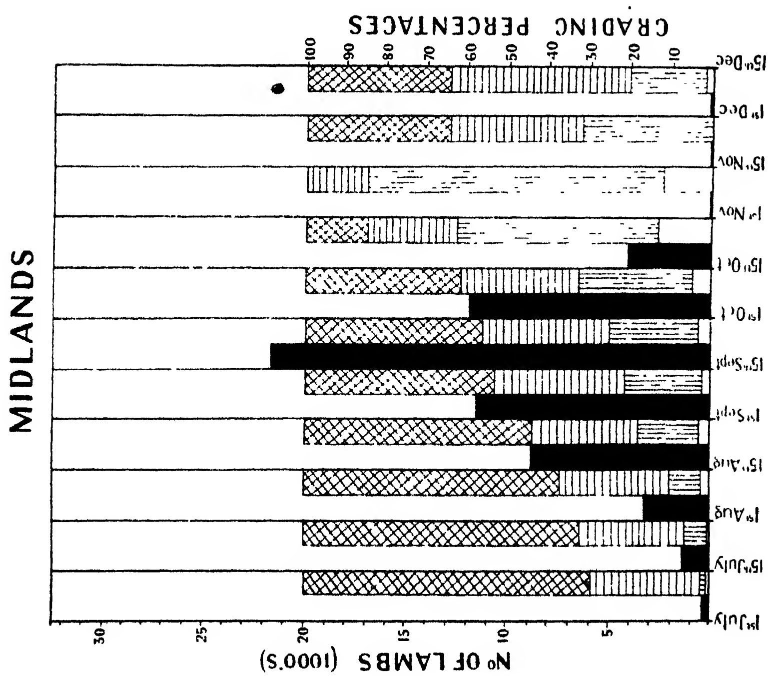

MIDLANDS
GRADING PERCENTAGES
100 90 80 70 60 50 40 30 20 10
No OF LAMBS (1000's)
30 25 20 15 10 5
1st July
15th July
1st Aug
15th Aug
1st Sept
15th Sept
1st Oct
15th Oct
1st Nov
15th Nov
1st Dec
15th Dec

Fig. 4.

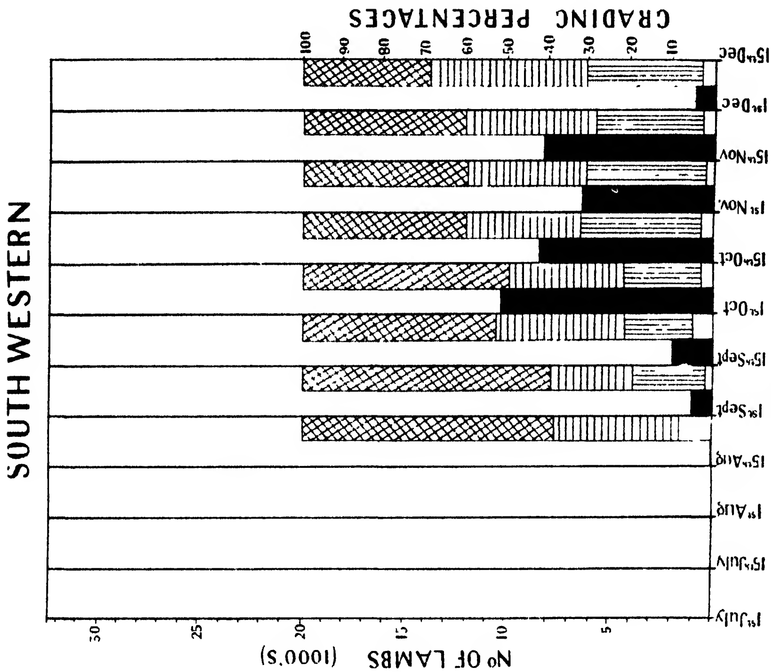

SOUTH WESTERN
GRADING PERCENTAGES
No OF LAMBS (1000's)

Fig. 7.

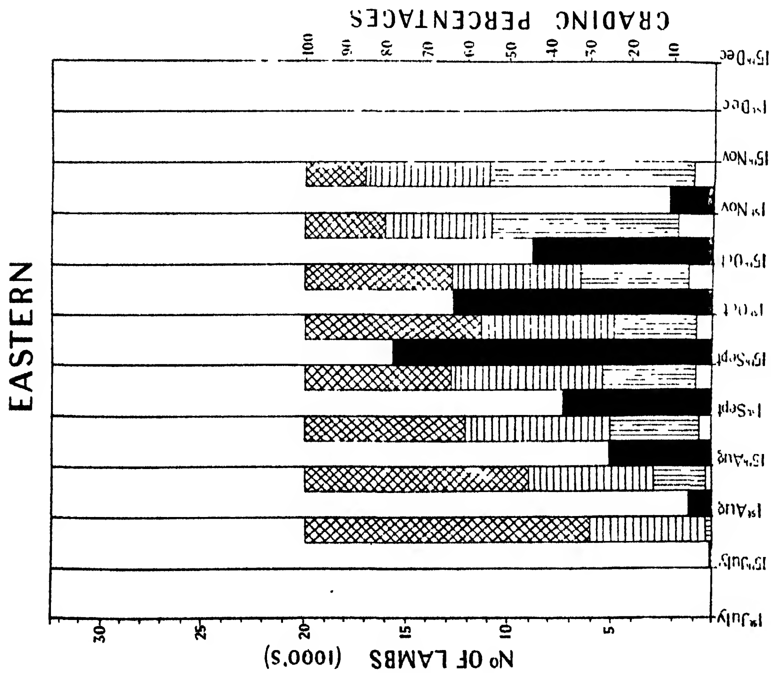

EASTERN
GRADING PERCENTAGES
No OF LAMBS (1000's)

Fig. 6.

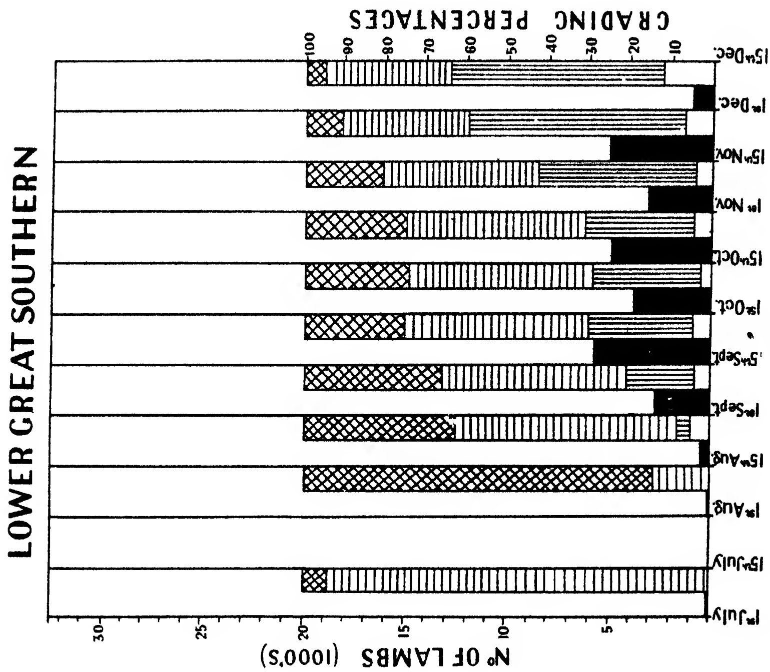

LOWER GREAT SOUTHERN
GRADING PERCENTAGES
Nº OF LAMBS (1000's)
1st July
15th July
1st Aug.
15th Aug.
1st Sept.
15th Sept.
1st Oct.
15th Oct.
1st Nov.
15th Nov.
1st Dec.
15th Dec.

Fig. 9.

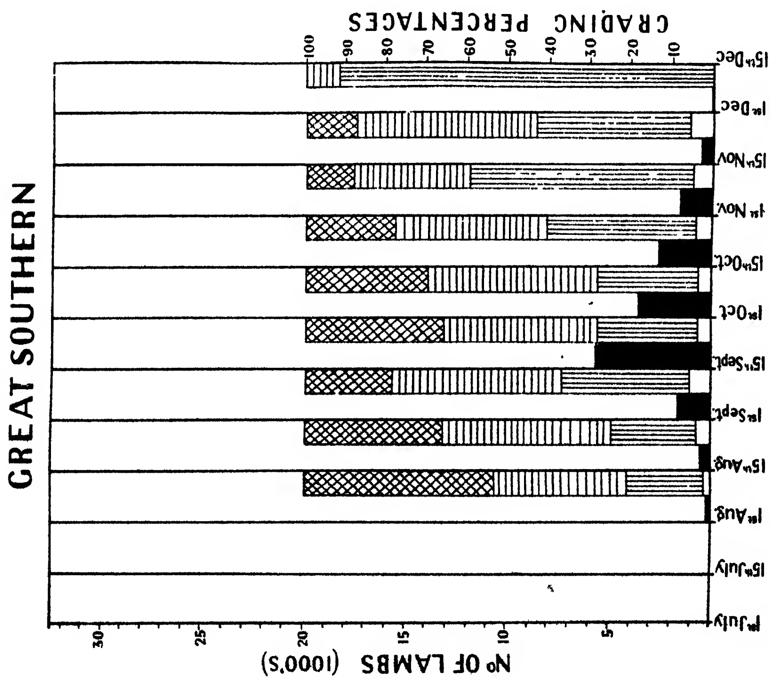

GREAT SOUTHERN
GRADING PERCENTAGES
Nº OF LAMBS (1000's)
1st July
15th July
1st Aug.
15th Aug.
1st Sept.
15th Sept.
1st Oct.
15th Oct.
1st Nov.
15th Nov.
1st Dec.
15th Dec.

Fig. 8.

In Figure 10 the percentage grading for half-monthly periods for the whole State is graphically represented.

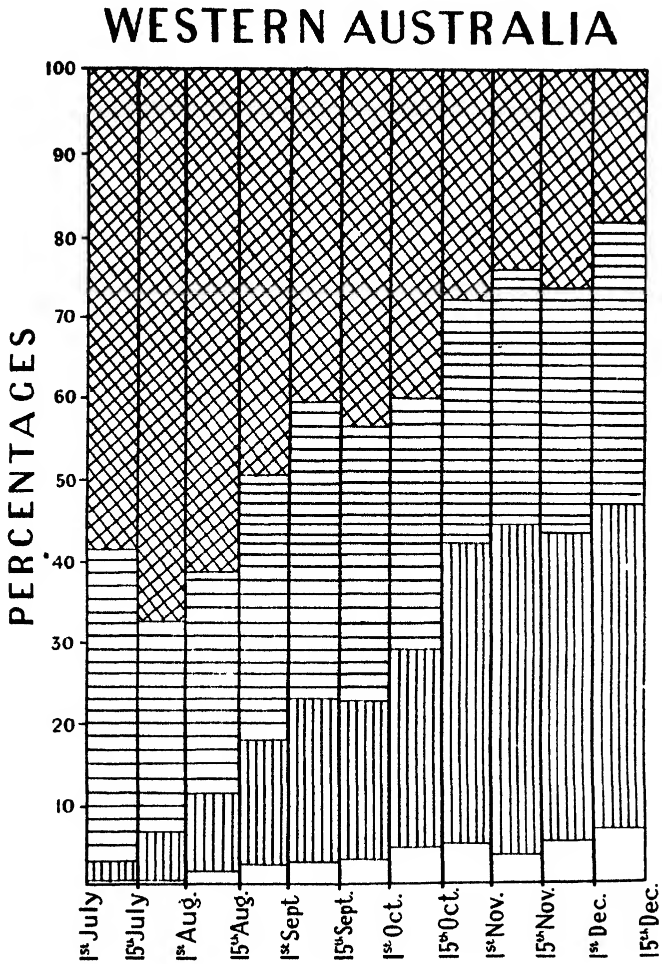


Fig. 10.

For the sake of simplicity, the total numbers treated in half-monthly periods are not included in this graph, but are to be found in Table 5. In this graph the chief feature is the steady decline of first-grade lambs as the season advances, and the corresponding increase in third-grade carcases, together with some increase in the number of rejects.

The authors again acknowledge their indebtedness to the various firms who made available the information upon which this analysis was based. They are particularly grateful to officers of the W.A. Meat Export Company and the Albany Freezing Works, without whose assistance in the shape of tabulated information concerning the grading of many hundreds of consignments of lambs, this study could not have been made.

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Agriculturists, pastoralists and primary producers generally, who may be having difficulties of any kind in connection with their production activities, are invited to communicate with the Agricultural Adviser of their district of the Department of Agriculture, when information and advice will be supplied free of charge.

Where identification of plant or stock diseases or insect pests is required, full details of symptoms should be forwarded and also samples of the diseased plant, animal tissue or insect where practicable. Plant tissue intended for examination by the Plant Pathologist should be wrapped in paper and not forwarded in airtight containers, and plant specimens for the Botanist should be pressed between newspaper and dried before despatch. With regard to animal tissue for microscopic examination, this should be forwarded in a solution of 10 per cent. formalin, or if of considerable bulk in a sealed kerosene tin containing a few ounces of formalin as a preservative. Living insects should be sent in suitable containers and dead specimens in methylated spirits.

The addresses and names of Advisers are as follows:—

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Bunbury	M. Cullity.
Busselton	J M. Nelson.
Geraldton	N. Davenport (Government Buildings).
Gosnells	R. C. Owen.
Harvey	R. L. Cailes (Fruit).
Katanning	A. S. Wild.
Kalamunda-Roleystone	W. H. Road, c/o. Department of Agriculture, Perth.
Kununoppin	W. M. Nunn.
Manjimup	C. M. Scott.
Metropolitan, Gingin, Chittering ...	S. E. Bennett, c/o. Department of Agriculture, Perth.
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Producer Gas for Agricultural Purposes.

E. E. FREETH, School of Engineering, University of Western Australia.*

FOREWORD.

Following extensive experiments dealing with producer design and operation carried out at the School of Engineering of the University of Western Australia, the present work was undertaken to obtain first-hand knowledge of the operation of Tractors, fitted with producer gas plant, working under Field conditions.

The work described in this publication has been carried out by E. E. Freeth, B.E., under the direction of Dr. A. T. Bowden, Assoc. Professor of Mechanical Engineering, and forms part of the research activities undertaken by the University through the Commonwealth Research Grant to Universities administered by the Council for Scientific and Industrial Research.

Without the practical assistance of many interested parties the work, involving as it does the use of a large amount of equipment, could not possibly have been carried out, and we therefore take the opportunity of thanking those who did so much to make for the successful completion of the work. In particular we are greatly indebted to the following:

F. Mather, Esq., Kellerberrin, who placed his farm and equipment at the disposal of the University.

Westralian Farmers, Ltd., for making available a set of rubber tyres for the tractor, a special drawbar attachment, the use of a dynamometer and cylinder gauge, for supplying for test a model "U" "Allis Chalmers" Tractor equipped with "Pioneer" gas plant.

Powell Gas Producers, Perth, for supplying and fitting a "Powell" producer plant.

Mr. Herbert, for making available and fitting a "Pioneer" producer plant.

Perth Motor Garage, who supplied and fitted a "Simplex" producer plant.

Messrs. H. V. McKay, Massey Harris Ltd., for supplying a 16 Tyne Sunduke Scarifier and for their very helpful co-operation in many other directions.

*This paper was prepared by the author and submitted as a thesis to the Faculty of Engineering of the University of Western Australia and is published herewith with the consent of the Dean of the Faculty.

Mr. Pallant, Kellerberrin, who allowed his harvesting to be done under test conditions.

The Shell Oil Co., for supplying lubricating oil and power kerosene used in the Field Trials.

A second series of tests carried out at Cranmore Park, Walebing, by courtesy of E. H. B. Lefroy, Esq., are in course of preparation and will, it is hoped, be published at an early date.

(Sgd.) A. T. BOWDEN,
University of Western Australia,
November, 1939.

INTRODUCTION.

In many parts of the world in recent years, an increasing amount of attention has been paid to the possibility of using producer or suction gas as a fuel for internal combustion engines. The term producer gas is here used to cover the wide range of mixed gases that are obtained by the gasification of wood, wood charcoal, or coke. In Australia, the use of coke is negligible as the coal supplies are limited.

In most countries, America being the chief exception, solid fuels in the form of wood, peat or coal are by far the cheapest forms of fuel. To obtain power from the fuel, it is necessary to burn it. There are three ways in which a solid fuel may be used. They are:—

(1) Complete combustion.

(2) Partial gasification.

(3) Complete gasification.

As there has, up to the present, been no successful device made that enables internal combustion engines to use solid fuel, the first two methods are of little use as a means of supplying fuel for transport and agricultural purposes. It has long been realised however that gas is the ideal fuel for the internal combustion engine, and all attempts to improve the performance of the petrol engine have been based on the principle of making the petrol-air mixture behave more like a gas mixture. In the evolution of the internal combustion engine, the liquid fuel certainly presented fewest difficulties. For this reason, it was natural at a time when manufacturers were doing their utmost to make a market for their products, that they should choose a fuel that gave least trouble and the best results. Therefore, the use of producer gas as a fuel for such engines was seriously considered only at such times as the price of petrol was high.

With the drive for economic self-sufficiency that has been created in many countries to-day, the advantage of using a solid fuel has become most marked. The Australian hardwoods appear to be eminently suited for making a charcoal that gives very good results when gasified.

When the internal combustion engine was first developed at the end of the last century, and the beginning of this, the idea of a mobile power unit was only just being put into practice, while many stationary units were in use. A number of such stationary units derived their power from producer gas.

The gas plants that were made at the beginning of the century, were in every way similar to the engines that they supplied with fuel. They were big and cumbersome and were only suitable for stationary work. To apply them for mobile

work, a tractor would have to be employed to move them, and would probably make use of all the fuel they could supply for that purpose so that it would be impossible to do any other work. The stationary engines that they supplied with fuel were similar and of the slow speed type with larger cylinders and immense flywheels. Usually one cylinder was considered sufficient and the more power required the larger the cylinder. An example of such an engine is one that was built in 1904 for the purpose of driving electrical apparatus. The engine was rated at 36 h.p., the cylinder dimensions being bore 8in., stroke 15in., the flywheel weighing 3 tons. Comparing this with a modern engine with a bore of 3½in. and stroke 5in., that is built in a four cylinder unit which develops 40 h.p. and yet has a total weight of approximately 500 lbs., the improvement has been made in the engines so why not make a similar one in the gas plants? In actual practice, the high speed engine presents a far easier problem to the designer of a gas plant than does the slow speed single cylinder engine because of the more constant rate of flow of the gases. With the engines, the main difference has been to increase the speed. Similarly if plants could be made to stand up to the use of much higher rates of gasification, they could be made on a scale comparable to that of the modern high speed multiple cylinder engine.

The work has not been entirely dropped, and towards the end of the last war, many people turned their minds to the problems connected with the use of gas in place of petrol. Their work received a setback when, after the war the price of petrol fell to such an extent that there was little advantage in the use of a solid fuel, and the extra work entailed seemed to balance the saving in fuel costs. The plants produced then were good, and had there been any incentive to continue in the manufacture on them for a few more years, there is no doubt that they would have produced a plant worthy of the modern car or truck engine.

In the last few years, the price of wheat has been falling in a steady but alarming manner. For this reason, several farmers started experimenting with the use of gas in their tractors to see if it were possible to lower their costs of production and so meet the lower wheat prices. Of the number who started working with only a rough idea of how the plants could be made, some had such highly satisfactory results that their neighbours persuaded them to make similar plants for them.

It so happened that these men found more interest in the manufacture of gas plants than in farming and so set out to make them on a commercial basis. It is needless to say that the greatest asset to this new industry was the oxy-acetelene welding process that enabled gas-tight seams to be made in sheet metal that would be unaffected by very high temperatures without having to resort to heavy plating with riveted and caulked joints that were always liable to buckling under the stresses set up by extremes of temperatures. However at first these pioneers were just doing what had previously been done in the other parts of the world. At the present time, they seem to have reached a stage that compares very favourably with that reached by the European countries.

At this stage, it was thought advisable to have some definite information gathered by unbiased observers, concerning the performance of tractors fitted with such plants. This would then enable the manufacturers to see along what lines further improvements were necessary, and at the same time let the farming community know exactly what benefits could be expected from the use of gas and the corresponding drawbacks so that a definite opinion could be formed as to whether gas would suit their requirements or not. To this end a tractor of fairly popular make was procured and its maximum power output using kerosene was obtained. Then as many of the local gas plants as could be obtained were fitted in turn to

the engine, and the maximum power output obtained in each case. All these tests were done in the laboratory of the Engineering School of the University of Western Australia. A selection of these plants were then tried under actual field conditions at Kellerberrin, the results of these trials being the basis of this report.

FIELD TESTS.

To determine tractor performance under field conditions, tests were made over a working period of about six months between September 1938 and March 1939. Farming operations undertaken included ploughing, stripper harvesting, cutting and binding, cultivating and scarifying. Owing to the seasonal period over which the tests were made, ploughing and to a certain extent cultivating, could not be done under normal working conditions, the ground being too dry and hard. Accordingly this point should be kept in mind where figures relating to such factors as drawbar horsepower and relative performances as between steel wheels and rubber tyres are concerned.

The tests were conducted on the property of F. Mather, Esq., of Kellerberrin, with the exception of the stripper harvesting which was done on the property of G. Pallant, Esq., also of Kellerberrin. The land consisted for the most part of sandy loan with irregular patches of blue clay, and was officially classed as salmon gum country.

Object of Tests.

The tests were designed to provide information relating to the performance of producer gas driven tractors working under Western Australian field conditions. Specific data was sought under the following headings:—

(1) Fuel consumption and power output.

(2) Comparison of performance when using—
   (a) Rubber tyres.
   (b) Steel wheels with spade lugs.

(3) Comparison of power output when using high and low compression pistons.

(4) Performance compared with that obtainable when using kerosene under comparable working conditions.

(5) Lubricating oil consumption and analysis.

(6) Cylinder wear.

(7) General observations of time and labour factors associated with usage of producer gas.

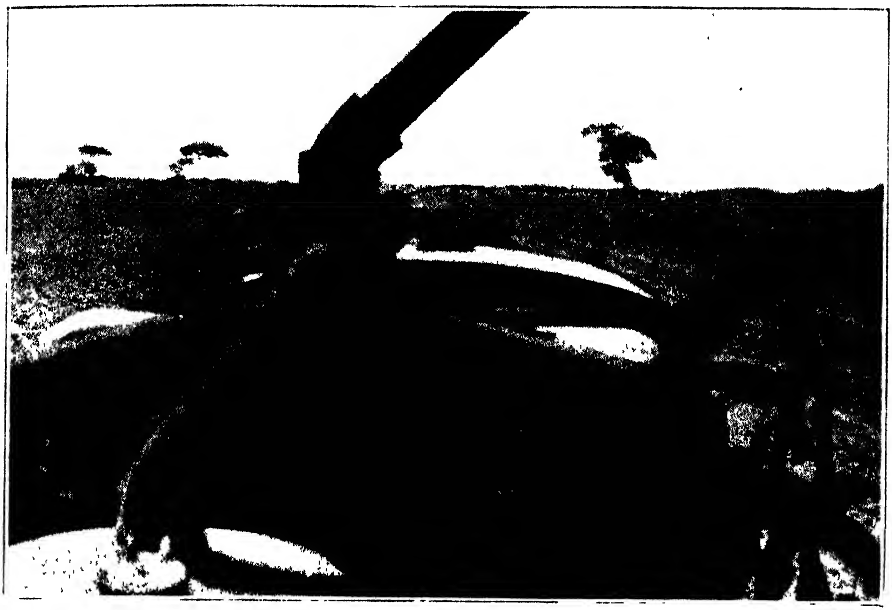
(8) Comparative analysis of working costs.

Details of Plant Used in Tests.

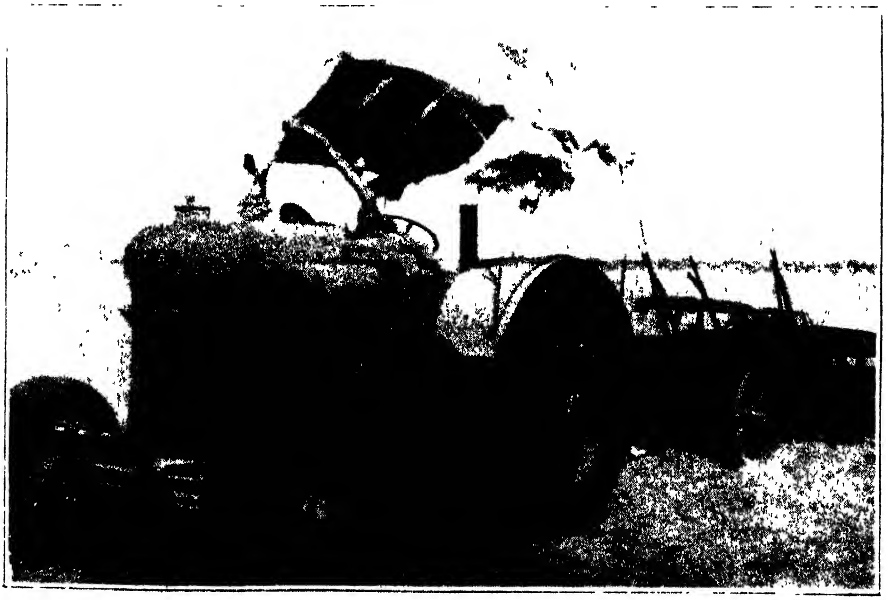
Tractor.

With the exception of the special tests carried out on an "Allis-Chalmers" Model "U" tractor and listed separately, all tests were made with a reconditioned "Case" Model "A" 12/20 tractor.

Apart from alteration of magneto timing to suit producer gas operation with fitting of special spark plugs, and high compression pistons, no structural alterations were made to the standard tractor.



Block 1
The "Case" 12-20 fitted for Kerosene



Block 2

Tractor Specifications:

Cylinders	4 Vertical.
Bore	4¼in.
Stroke	5in.
Rated R.P.M.	1,050.
Gear Ratios	High = 49:1. Low = 66.6:1. Reverse = 98:1.

Corresponding to speeds of 3 m.p.h., 2.2 m.p.h., 1½ m.p.h.

Total weight as fitted for burning kerosense: 4,450 lbs.

Rated Output:

Engine: Brake horsepower 20.
Drawbar- horsepower (Steel Wheels) 12.
Draw-bar horsepower (Rubber Tyres) not rated.

Dynamometer tests carried out at the School of Engineering of the University of Western Australia prior to the field tests gave a maximum continuous output of 23.75 brake horsepower.

Producer Units.

The producer units used in the tests were standard units of types made and marketed in Western Australia. The units were supplied and fitted to the tractor by the makers, who supplied exhaust and inlet manifolds, and such other fittings as in their opinion were considered desirable.

Three types of producer plant were tested, comprising:—

(1) "Powell."

(2) Herbert "Pioneer."

(3) "Simplex."

(1)—*"Powell": Brief specifications:*

Total weight 450 lbs.

Generator—Overall dimensions 4ft. 6in. x 18in. Up-draught, double shell, constant length flame path type; 3-point gas take-off, firebox 3/16 M.S. plate; shell 1/16 M.S. plate; grate, cast iron. Powell Patent Cross-section: Area of firebox 1.262 sq. ft. Length of flame path 18 inches. Maximum rate of gasification 34.8 cu. ft. per minute per square foot of firebox.

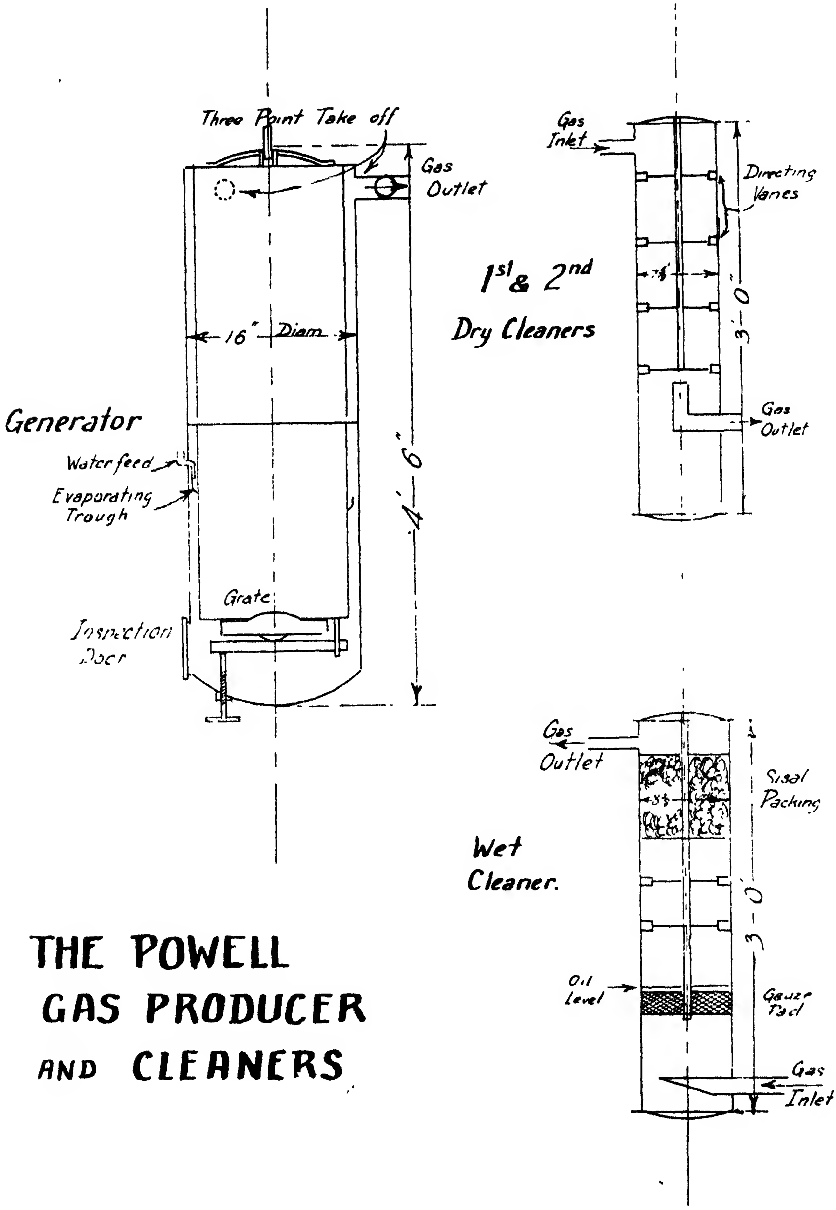
Cleaners—2 dry cleaners each 3ft. x 7⅝in. diameter, windmill type downward flow. One oil cleaner 3ft. x 8⅝in. diameter. Powell patent upward flow of gas and oil vapour past windmill vanes to sisal hemp dryer.

Cooler—None.

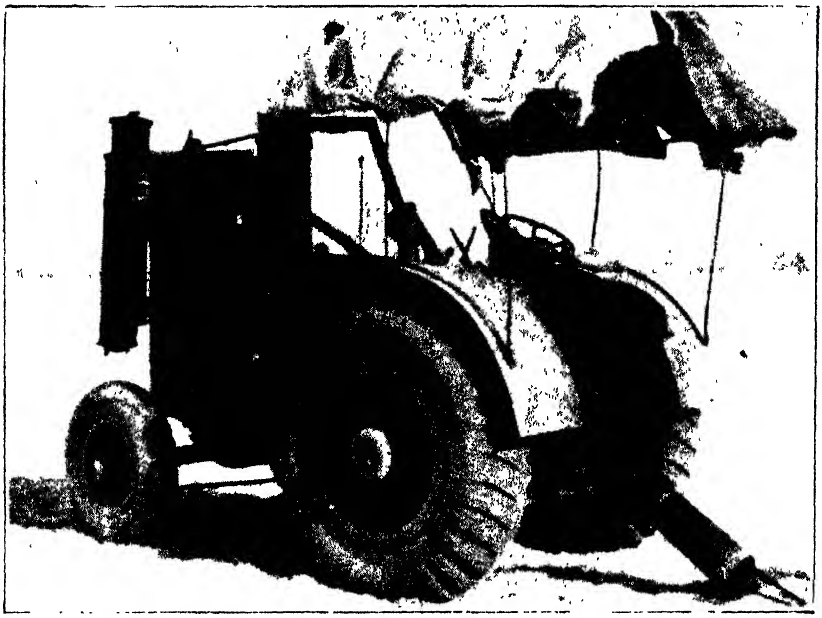
Situation on tractor—Generator in front of radiator. Dry cleaners on left of generator in front of radiator. Oil cleaner in position usually occupied by kerosene tank between radiator and engine above fan.

Controls—Water control. Drip feed; hand controlled valve situated under tank attached to generator. Extension rod brings control to driving position.

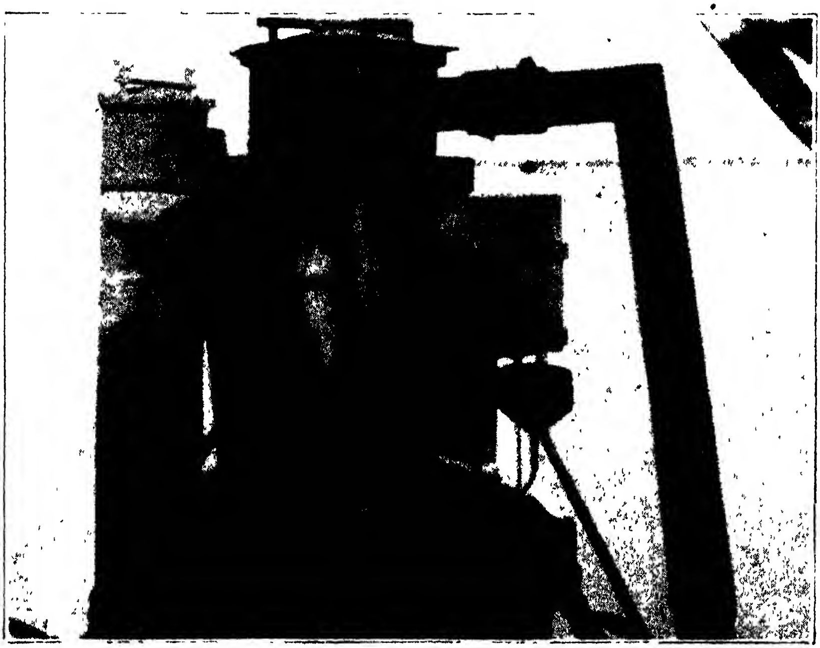
Air and gas control—Butterfly valves set in the air and gas lines controlled by hand levers set near petrol throttle and spark control levers.


Three Point Take off
Gas Outlet
16" Diam
Generator
Water feed
Evaporating Trough
Grate
Inspection Door
4'-6"
Gas Inlet
Directing Vanes
1st & 2nd
Dry Cleaners
3'-0"
Gas Outlet
Gas Outlet
Sisal Packing
Wet Cleaner.
3'-0"
Oil Level
Gauze Pad
Gas Inlet
THE POWELL
GAS PRODUCER
AND CLEANERS

Block 3.



Block 4
The "Case" 12 20 fitted with "Powell" Gas Producer

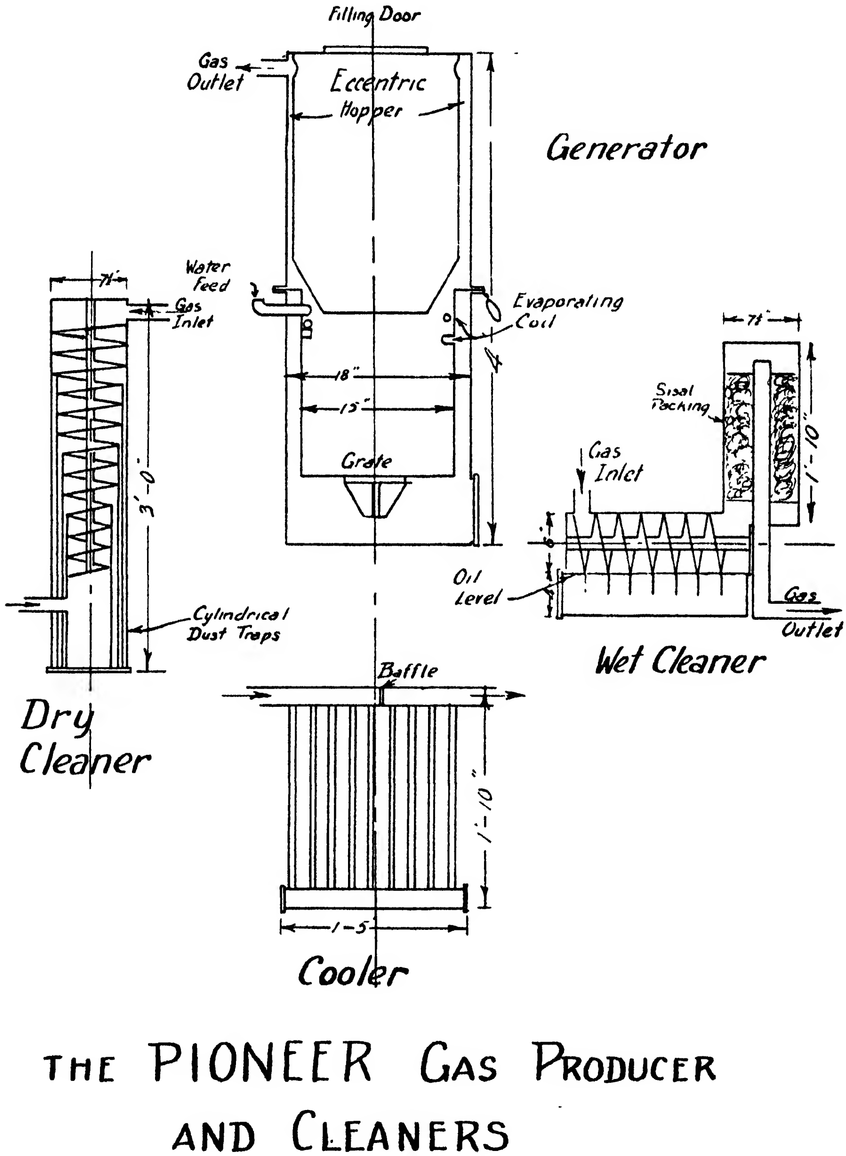


Block 5.

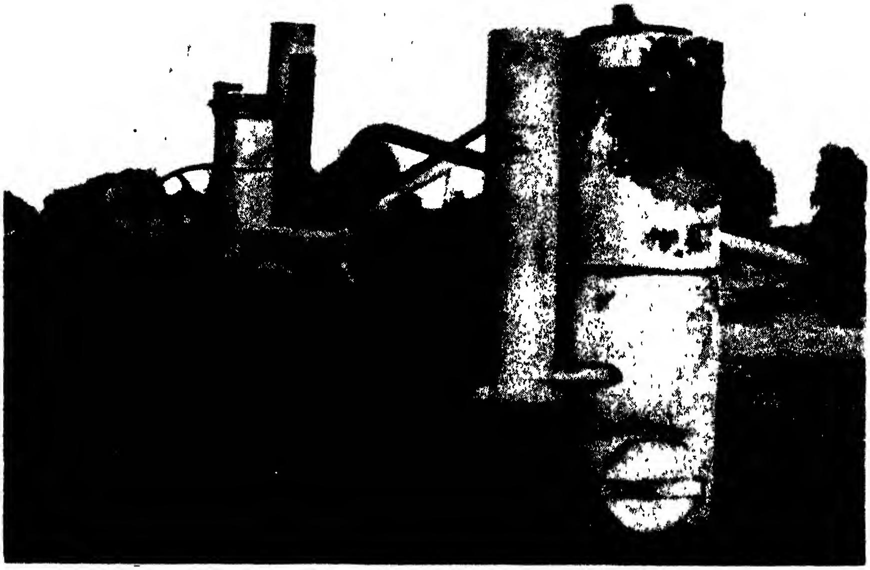
(2)—*Herbert "Pioneer": Brief specifications:*

Total weight 336 lbs.

Generator—Up-draught; double shell; constant length flame path; single point take-off; eccentric hopper. Firebox ¼ M.S. plate. Shell and hopper 16 S.W.G. M.S. plate. Grate, cast iron slotted cone shaped. Area of firebox 1.070 sq. ft. Length of flame path 13½ inches. Max. rate of gasification 34.6 cu. ft. per minute per sq. ft. of firebox. Overall dimensions: 4ft. x 18in. diameter.



Block 6.



Block 7
The "Case" 12-20 fitted with "Pioneer" Gas Producer

Cleaners—One dry cleaner, centrifugal; vertical spiral attached to generator. Overall dimensions: 3ft. x 7½in. diameter. One oil cleaner, horizontal spiral on contact with oil with sisal hemp dryer. Overall dimensions: 2ft. x 6in. x 2ft. x 7½in.

Cooler—Double flow multi-tube radiator placed in front of engine radiator.

Situation on tractor—Generator on reinforced plate in front of tractor. Dry cleaner attached to side. Cooler in front of engine radiator. Oil cleaner alongside the kerosene tank.

Controls—Water. Drip feed; valve at side of kerosene tank which serves as water reservoir. Adjusted from ground alongside the tractor. For test purposes, an extension control enabled the water to be regulated from the driving position. Gas and air: The petrol throttle serves as air control; butterfly valve, set in gas line operated from hand lever near spark control lever, controls the gas supply.

(3)—"*Simplex*": *Brief specifications*:

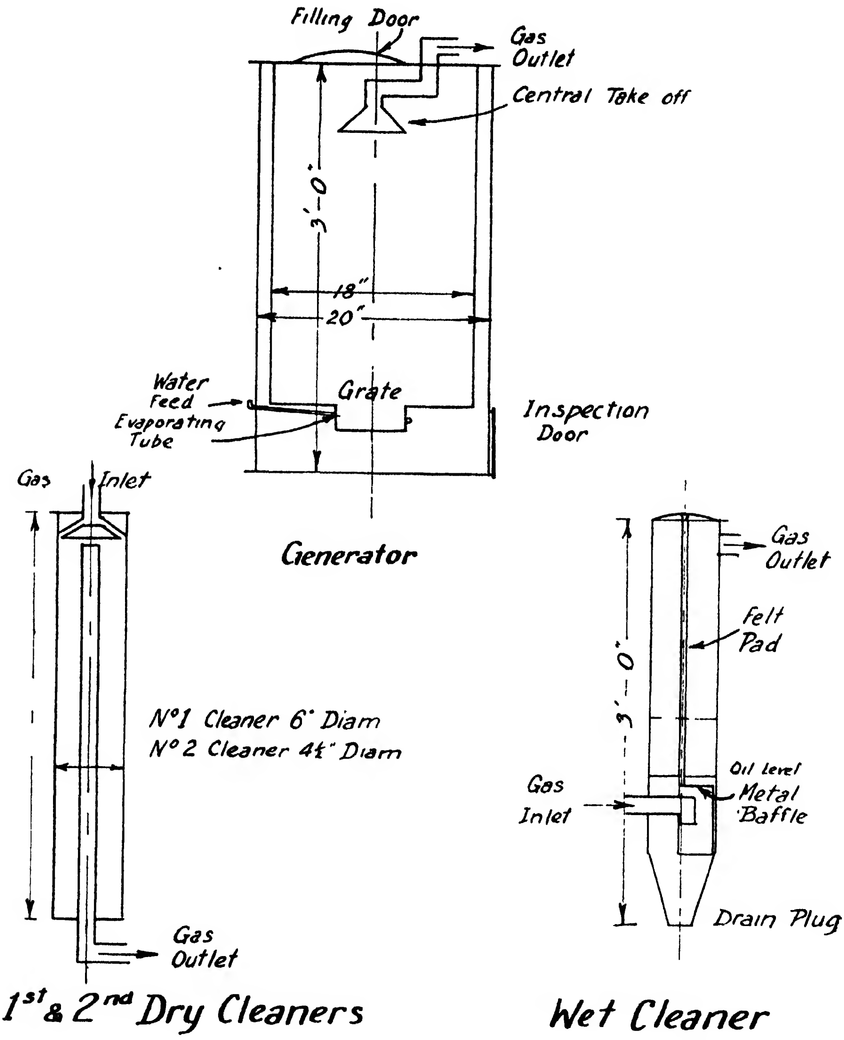
Total weight 280 lbs.

Generator—Updraught; double shell; variable length flame path; central gas take-off. 18 S.W.G. plate throughout. Grate: tuyere type with C.I. heavy section fire bar. Area of firebox 1.77 sq. ft. Max. rate of gasification 20.9 cu. ft. per minute per sq. ft. of firebox. Overall dimensions: 2ft. 8½in. x 2ft. 10in. x 3ft. 6in.

Cleaners—Two dry cleaners employing a downwards and outwards rotary motion of the gas to effect the separation of the dust from the gas. One oil cleaner employing a felt filter pad kept moist with oil vapour collected by passage of the gas through an oil bath.

Cooler—None.

Situation on tractor—Generator with cleaners grouped round it situated on common base and top-plates in front of radiator.



THE SIMPLEX GAS PRODUCER AND CLEANERS.

Block 8.

Block 9.
The "Case" 12-20 fitted with 'Simplex' Gas Producer

Controls—Water. Valve under kerosene tank controls drip-feed. Air: situated between second dry cleaner and oil cleaner adjustable from in front of tractor. Gas: gate valve in gas line controls amount of mixture—can be reached from driving position.

Implements.

(1) Ploughs:

(a) 5-furrow Smith type mouldboard plough, stump jump steel frame.

(b) 8-furrow Smith type mouldboard plough, stump jump steel frame.

(2) Scarifier 16-tyne "Sunduke" scarifier made by H. V. McKay, Massey-Harris Ltd., steel frame, stump jump, rigid tyne, spring controlled.

(3) Harvester—"Sunshine" 10ft. "E" type stripper harvester made by H. V. McKay-Massey-Harris Ltd.

(4) Binder:

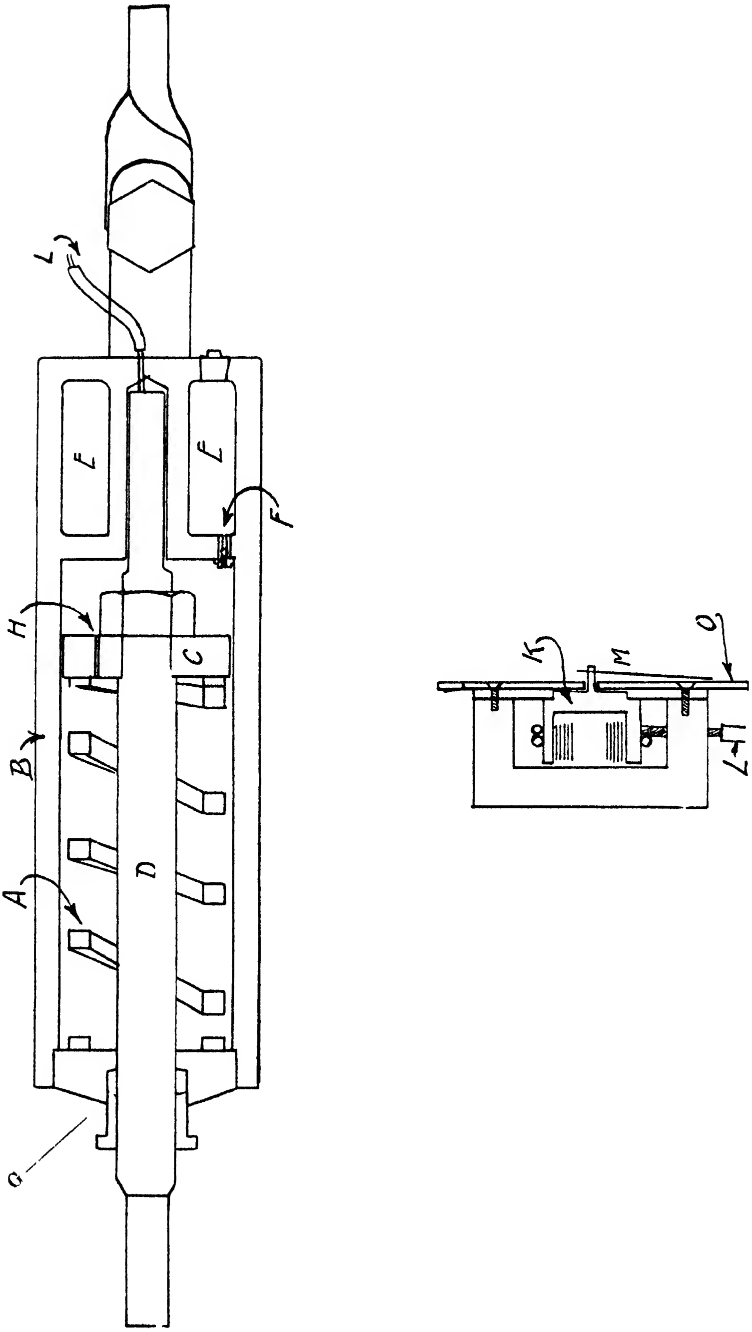
(a) 8ft. cutter and binder made by McCormick-Deering Co.

(b) 8ft. cutter and binder made by H. V. McKay, Massey-Harris Ltd.

METHOD OF CONDUCTING TESTS.

(a) *General.*

In order that the useful power output might be divided from the total power output, no-load tests were run over prolonged periods as grounds and climatic conditions changed appreciably.



TRACTION DYNAMOMETER.

Block 10.

(b) *Draw-Bar Pull.*

The implements used in the tests were coupled to the tractor through a traction dynamometer. Observations of the pull were recorded at regular five minute intervals.

During the initial stages of the tests, two types of dynamometer were successively used—the Chatillon Dynamometer operating on the principle of the variation in length under load of the minor axis of an elliptical spring, and the Salter balance using four coil tension springs in parallel. Frequent checks showed that both types were unsuited to continuous operation on account of wear in the recording mechanism and therefore a special instrument designed in the Department of Mechanical Engineering of the Engineering School was adopted.

As shown in Fig. 10 the dynamometer consists of a single heavy coil spring A, working in a completely oil filled cylinder B against a piston C coupled through a piston rod D to the tractor. The oil reservoir E communicates with the main cylinder through the non-return valve F and so enables leakage through the gland G to be made up. Small holes H in the piston enable the oil in the cylinder to dampen small rapid variations in pull.

The movement of the piston rod D is communicated to the spring loaded drum K of the recording mechanism through the Bowden cable L. Attached to the drum K, the adjustable pointer M works over the calibrated dial O.

The dynamometer was continuously coupled to the tractor and frequent checkings showed consistent accuracy.

(c) *Tractor Speed.*

The method adopted for computing the speed and distance covered was based on the assumption that no slipping of the front wheels takes place under normal working conditions. By a simple trigger mechanism, the revolutions of the front wheels were taken to a revolution counter housed conveniently near the driving seat. The revolutions were read every five minutes concurrently with the load as recorded on the dynamometer. The distance travelled in terms of front wheel revolutions was checked against actual measurement as change of country and weather conditions demanded.

(d) *Fuel Consumption.*

(1) *Charcoal*: All fuel was weighed immediately before being put into the hopper. At the end of the period over which the consumption test was being made, the generator was completely emptied and the residue weighed--all weights being made on a steelyard and the weight of the containers being deducted.

(2) *Water*: The weight of water put in the tank every morning before starting was noted. The residue remaining at the end of the period of work being weighed and the difference giving the weight of water used.

(3) *Petrol*: The petrol put in the tank was weighed but the tank was not drained regularly. Petrol was added when the quantity in the tank was less than one pint.

(4) *Kerosene*: The kerosene was weighed as it was put in the tank, and the residue at the end of the test period drained and weighed.

(e) *Maximum Load Tests.*

These were carried out at intervals during the tests and finally a comparative maximum load test was made for which all plants were tested for their maximum load within a week in order to obtain similar conditions.

To obtain the maximum load, readings of the dynamometer and revolution counter were taken every half-minute. As it was found that while the maximum power output occurred at the working speed, but a considerably greater pull could be maintained at a lower speed, three sets of readings were taken.

(a) Maximum power: Maximum pull at working speed of tractor from readings taken at half-minute intervals.

(b) Maximum pull: Maximum pull at a constant speed that could be maintained, but which was definitely less than working speed.

(c) Stalling load: Pull which would stop the tractor in just under half a minute.

(f) *Oil Consumption and Method of Sampling.*

Oil samples were taken at regular intervals from the crankcase of the engine always after the engine had been working, and generally with the engine running to ensure a representative sample

Replenishing of the oil was done after the sample had been taken. The oil from each test was taken from the one tin and the quantity of oil used being calculated at the end of the test. This method was adopted as the samples taken were so small that any field method of computing the amount of oil taken out or replaced would have been very inaccurate.

The samples were analysed by Messrs. D. C. Dodd and E. E. Jarvis at the University of Western Australia.

(g) *Cylinder Wear.*

An Ames cylinder barrel gauge was used to measure the wear in the cylinder. This measurement was made after every test period with each plant. The measurements were made at three points in the barrel—at the top; at the mid-point; at the bottom. In each of these places, readings were averaged and the mean taken as the diameter in each point.

RESULTS OF TESTS.

Power and Consumption Tests with Producer Gas.

General: In recording the results of the power and consumption tests, the daily log sheets (of which a specimen is shown on page 386), have been summarised to show the average figures for the complete daily run. General remarks relating to plant behaviour and features deserving special note have been retained in full as observed.

Fuel: White gum charcoal ex Chidlow, Western Australia. Retort burned by W. Somerville, cost £2 5s. per ton f.o.r. Chidlow.

The charcoal fuel used throughout the test was received in one batch from the manufacturer and was representative of a reasonably clean well-burned charcoal.

Specimen Page of Log.

PRODUCER GAS FIELD TRIALS AT KELLERBERRIN, W.A.

Date: Tuesday, 11th October, 1938. Plant: "Powell" (Rubbers).

Time.	Load.	Revs.	Remarks.	Time.	Load.	Revs.	Remarks.
8·43	...	54,749	Starting.	1·40	1,300	59,542	On gas 2 min.
8·45	1,400	54,798		1·45	1,600	59,637	
8.48	...	54,864		1·50	1,800	59,733	
8·50	1,000	54,924		1·55	1,800	59,842	
8·55	1,400	55,013		2·00	1,900	59,948	
9·00	1,800	55,147		2·10	1,500	60,108	
9·05	1,800	55,285		2·15	1,500	60,262	
9·10	1,700	55,384		2·20	2,000	60,416	
9·15	1,900	55,552		2·25	1,700	60,571	
9·20	1,300	55,687		2·30	1,500	60,728	
9·25	1,500	55,830		2·35	2,000	60,886	
9·30	1,700	55,966		2·40	1,600	61,040	
9·35	1,400	56,109		2·45	1,400	61,197	
9·40	2,000	56,214		2 50	1,500	61,354	
9·45	1,500	56,351		2·55	1,300	61,510	
9·50	1,800	56,473		3·00	1,600	61,667	
9·55	1,500	56,654		3·05	2,000	61,811	
10·00	1,000	56,775		3·10	2,000	61,924	
10·09	1,500	56,829		3·15	1,800	62,053	
10·10	1,500	56,829		3·25	1,800	62,215	
10·15	1,700	56,977		3·30	2,000	62,299	
10·20	1,900	57,120		3·35	2,000	62,414	
10·25	1,700	57,277		3·40	2,000	62,535	
10·30	1,500	57,459		3·50	2,100	62,771	
10·40	1,600	57,740		3·55	1,400	62,900	
10·41	30	...	Off Load 3½ min.	4·00	1,000	62,962	
10·50	1,600	57,890		4·05	1,400	63,102	
10·55	1,600	57,992		4·10	1,500	63,250	
11·00	1,500	58,146		4·15	2,000	63,383	
11·05	1,500	58,296		4·20	1,900	63,510	
11·10	2,000	58,444		4·26	1,800	63,625	
11·15	1,600	58,594		4·30	1,800	63,735	
11·20	1,400	58,721		4·35	1,500	63,873	
11·25	1,300	58,820	Off Load 6 min.	4·40	1,700	63,984	
11·35	1,800	58,940		4·45	1,600	64,107	
11·40	2,000	59,082		4·50	1,800	64,235	
11·45	1,600	59,255		4·55	1,900	64,363	
11·50	2,000	59,379		5·00	2,100	64,485	
12·00	1,400	59,534	Stop.	5·05	1,300	64,593	
				5·10	1,500	64,761	

		lbs.
Fuel put in:	Charcoal (56, 30¾, 60¾, 60)	207½
	Water	42½
Taken out:	Charcoal	38¾
	Water	½

Tyre Pressures: 12, 12½.
On Gas: 4 minutes.
Average Load: 1,650 lbs. corrected 1,890 lbs.
Average Speed: 27·6 r.p.m. = 3·47 ft. per second.

Time of Working.

hrs.	min.
6	35
148	16
154	51

Fuel consumed: 105½ lbs. charcoal.
38¼ lbs. water.

GROUP 1.

SERIES A.

Using high compression and rubber tyres.
Pistons: Cast iron normal construction giving compression ratio 7.8 : 1.
Ignition advance: 20° of engine crankshaft.
Tyres: Barnet Glass, 4 ply. 11.25 x 24.
Wheels and Rims: Cast iron one piece heavy section.

SERIES A (1).—"POWELL" GAS PLANT USING HIGH COMPRESSION AND RUBBER TYRES

Spark Plugs :—Leggetts "L-4" (9-9-38—6-10-38) Pyrox PZ 30K (6-10-38—15-10-38).

Date.	Time of Working.	Average Load.	Average Speed.	Average Draw-bar.	Time on Petrol.	Petrol Used.		Fuel Used: Total.	Fuel Used: Per d.b.h.p. hr.	Fuel Used: Per Acre	Water Used: Total.		Water Used: Per d.b.h.p. hr.	Per lb. Fuel.	Area Worked.	Remarks.
	min.	lbs.	ft./sec.	H.P.	min	lbs	gal	lbs.	lbs.	lbs.	lbs.	gal	lbs.	lbs.	acres.	
(a) Ploughing—																
9-9-38 ..	448	785	4·13	5·9	10	12?	1 6	137·0	3·12	23·8		..			5·77	Water not checked at end.
10-9-38 ...	235	742	4·01	5·41	4			69·5	3·25	22 8	29·0	2·9	1·364	0·418	3·05	
12-9-38	155	703	4·44	5·67	4			61·0	4·16	28 2	17·25	1·725	1·175	0·283	2·035	
13-9-38 ...	459	822	3·94	5·89	8			184 0	4·09	24·1	12·75	1·275	0·283	0·0693	7·65	8 Furrow Plough.
14-9-38 ..	418	1,028	4·01	7·5	11	9 0	1·128	145 25	2·775	22 4	10·0	1·0	0·191	0·0688	6·5	7 Furrow Plough.
16-9-38 ..	157	1,100	4·1	8·2	6			77·0	3 56	21·9	2·0	0·2	0·093	0·026	3·06	
10-10-38	133	1,920	4·13	14 41	6	10·0	1·26	91·5	2·86	30·8	15 25	1·525	0·478	0·166	2·97	8 Furrow Plough
11-10-38 ..	367	1,890	3·47	11·93	6			165·5	2·26	23·9	38·25	3·825	0·535	0·231	6·92	
12-10-38 ..	326	1,878	3·41	11·63	11			146·5	2·3	24·4	29·25	2·925	0·464	0·1985	5·97	
(b) Binding—																
27-9-38 ..	300	635	4·09	4·73	12			110·5	4·71	10·78	15·5	1·55	0·655	0·1388	10 25	
28-9-38 .	396	609	4·15	4·59	8	.	.	134·5	4·44	10·05	13·65	1·365	0·45	0·1013	13·4	Engine not stopped all day.
29-9-38 ..	336	607	4·17	4·6	9	6·0	0·756	130 5	5·06	10·4	23·25	2·325	0·902	0 178	12 5	
30-9-38 ...	551	583	4·15	4·40	11			145·5	3·6	7·275	8·5	0·85	0·199	0·0553	20 0	
1-10-38 .	496	580	4·17	4·40	9	4·5	0·567	159 5	4·39	9·2	24·5	2·45	0·675	0·1535	17·3	
3-10-38	479	585	4·21	4·47	12			161·5	4·63	9·05	19·5	1·95	0·0546	0 195	17·85	
4-10-38	431	580	3·9	4·12	10	10·0	1 26	162·5	5 51	10·88	20·5	2 05	0·695	0·126	14·95	
5-10-38 ..	383	590	4·1	4 4	9			158·0	5 62	10·41	27·0	2·7	0·96	0 171	15·17	
6-10-38 ..	424	600	4·16	4·54	5			159·0	4·97	9·2	20·7	2·07	0·645	0·1253	17·31	Spark Plugs Changed
7-10-38 ..	317	871	4·16	6·58	8	8·0	1·01	139·5	4·02	10·82	41·0	4·1	1 18	0 293	12·88	40 min. scarifying.
8-10-38 .	321	590	4·14	4·44	7	3·0	0 379	142·0	5·99	10 83	64 5	6·45	2·72	0·454	13·1	
13-10-38	135	606	4·09	4·5	5		..	73·0	7·21	10 5	11 0	1·1	1·88	0·151	6·95	
(c) Cultivating—																
14-10-38 .	299	902	3·96	6·5	6	7·6	0·9	133·0	4·1	11·7	13·25	1·325	0·409	0·0995	11·38	
(d) No. Load Tests—																
12-9-38	161		4·4	.	4			41·0	13·4 (lbs./hr.)	0·058 (lbs /ch.)	14·25	1·425			735 chs.	
(e) Maximum Load Test—																
16-10-38	40	Max Load at 4·14 ft./sec., 2,100 lbs. = 15 8 d.b.h.p. Maximum Pull 2,300 lbs at 3 02 ft. sec = 12·6 d.b.h.p. ; stalling load = 2,680 lbs.														
27-1-39	53	„ „ 4 3 ft./sec., 1,900 lbs = 14 85 d.b.h.p. „ , 2,128 lbs. at 2 5 ft./sec. = 9·7 d.b.h.p. : stalling load = 2,465 lbs.														

Remarks.—The high fuel consumption when working on the light load of binding is accounted for by the high proportion of the engine power developed that is required to propel the tractor, *e.g.*, taking 3-10-38.

The fuel used per hour 20·2 lbs., fuel required to propel the tractor per hour 13·4. Therefore fuel per hour used for work 6·8 lbs. or 1 52 lbs. per h.p.hr.. which agrees with the consumption figures obtained from the bench tests.

SERIES A (2)—HERBERT "PIONEER" GAS PLANT USING HIGH COMPRESSION AND RUBBER TYRES.

Spark Plugs KLG 669J

Date.	Time of Working.	Average Load.	Average Speed.	Average Draw-bar	Time on Petrol	Petrol Used		Fuel Used.			Water Used.			Area Worked. Acres.	Remarks.
								Total.	Per d.b.h p hr.	Per Acre hr.	Total.	Per d b.h.p hr	Per lb. Fuel.		
	min.	lbs.	ft./sec.	H.P.	min.	lbs	gal.	lbs.	lbs.		lbs.	lbs.	lbs.	acres.	
(a) Scarifying—															
2-11-38	312	1,700	3·93	12·15	7			152 0	2 4	12·71	29·0	0 466	0·191	11·95	
3-11-38	437	1,840	3·9	13 05	7	9 75		174 0	1 83	9 95	42·0	0·442	0 241	17·48	
4-11-38	463	1,770	4·04	13 0	9			168 0	1·676	10·25	46·0	0·459	0·274	16·38	
5-11-38	174	1,960	4·07	14·5	10			115 0	2 71	16·95	20·0	0 477	0·174	6·8	
14-11-38	157	1,405	3·99	10 18	18			81 0	3 05	11 84	10·0	0 376	0·1235	6·85	Jarrah Charcoal.
(b) Harvesting—															
10-11-38	335	1,280	4·07	9 47	18			141 5	2 67	8 75	35 0	0 663	0 247	16·15	
11-11-38	340	1,335	3 96	9 6	19	8		131·25	2·28	7·9	31·0	0 538	0·236	16·63	
12-11-38	147	1,350	4·1	10·05	5			47·0	1·91	6 3	10 0	0 407	0 213	7·46	
15-11-38 ..	355	1,040	4 0	7·57	7			177·0			26·25			18·0	Firebox not emptied.
16-11-38	269	970	4·07	7·35	11	10·75		122·0	3·35	8·1	15·5	0 552	0·165	15·85	
17-11-38 ..	317	1,065	4·04	7·8	8			99·5			24·0				Consumption figures for 3 days.
(c) No. Load Test—															
21-11-38 ..	158		4·1		7			44·0	16·7 (lb./hr.)		4·5	1·71 (lb./hr.)		702 ch.	
(d) Maximum Load Test—															
25-1-39 .	57	Maximum Power at 4 3 ft./sec., 2,018 lbs. = 15 4 d.b.h.p.						Maximum Pull 2,350 lbs. at 2·5 ft./sec., = 10·7 d.b.h.p.							Stalling Load = 2,580 lbs.
14-11-38	30	Maximum Power at 4·14 ft./sec., 2,100 lbs. = 15·7 d.b.h.p.						Maximum Pull 2,200 lbs. at 2·6 ft./sec., = 10·6 d.b.h.p.							Stalling Load = 2,610 lbs.

SERIES A (3)—"SIMPLEX" GAS PLANT USING HIGH COMPRESSION AND RUBBER TYRES.

Spark Plugs—AC (28-11-38—14-1-39); KLG. PKA 3 (16-1-39—26-1-39).

Date.	Time of Working.	Average Load.	Average Speed.	Average Draw-bar.	Time on Petrol.	Petrol Used.		Fuel Used.			Water Used.			Area Worked.	Remarks.
								Total.	Per d.b.h.p. hr.	Per Acre.	Total.	Per d.b.h.p. hr.	Per lb. Fuel.		
	min.	lbs.	ft./sec.	h.p.	min.	lbs.	gals.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	acres.	
(a) Harvesting—															
28-11-38 ...	288	1,100	4·06	8·12	21	6 0		179 0			44 5			14·75	Fuel consumption over 2 days.
29-11-38 .	274	1,170	3 97	8·44	12	12 0		71·0	3·2	9·72	10·75	0·71	0·221	13 45	
30-11-38 ..	279	1,220	4·13	9·15	10			184·0	2 55	7 6	41·5	0·894	0·351	14·25	
1-12-38 ..	259	1,220	4·04	8·95	33	9·5		22·5			31·0			12·92	Plugs fouled with oil (12·15)
2-12-38 ...	314	1,160	4·105	8·66	22			173 5	3·25	9 06	34·25	0 828	0·255	15·9	
3-12-38 ...	228	1,115	4·095	8·3	15	11 0		75·75			29·25			11·55	
5-12-38 ...	367	1,120	4·11	8·37	12			111·0	2·17	5 94	29·5	0 576	0·266	18·67	
6-12-38 ...	388	1,120	4·12	8·39	8			196 0	2·365	6·15	51·5	0·715	0·305	19·8	
7-12-38 .	236	930	4·07	6·99	27	9·0		3·0			13·75			11·9	
8-12-38 .	276	1,120	4·1	8·35	23			184·0			32·25			14·0	
9-12-38 .	265	1,120	4·09	8·33	21	9 0		69·0	2·55	7·1	40·0	0·73	0 285	13·4	
10-12-38	161	1,185	4·13	8 9	11									8 23	
12-12-38	342	1,440	4·12	10·78	18	12·0		182·0			35 75			17·4	Harvesting on slope.
13-12-38 .	196	1,125	4·1	8·36	13			178·0	2 62	7·7	42·5	0·735	0 281	9·95	Havester trouble.
14-12-38 ..	298	1,160	4·09	8·64	26			65·0			37·25			15·06	Cultivating, 9-1 p.m.
15-12-38 ..	348	1,060	4·08	7·88	32			29·0			15·0			17·6	Fire box burned out, 6·45 p.m.
(b) Cultivating—															
13-1-39	118	1,170	4·09	8·70	7			125 0	4 45	16 13	32 0	1 98	0 445	4·77	Maximum continuous load, 1,460 lbs.
14-1-39	82	1,150	4·08	8·53	4			3 0			25·0			3 21	
16-1-39	273	1,355	4·07	10·0	12			166·0	2 72	12 1	55·25	0·9	0 331	10·68	New Plugs. Maximum load, 1,750 lbs.
17-1-39	78	1,619	4 05	11·9	10									3·03	

(c) Maximum Load Tests—

17-1-39 . Maximum Load at 4 1 ft./sec., 1,760 lbs. = 13 1 d.b.h.p. Maximum Pull at 2·5 ft. sec, 1,950 lbs = 8 85 d b.h.p. Stalling Load = 2,100 lbs.

23-1-39 Maximum Power at 4·2 ft sec., 1,900 lbs. = 14·5 d b.h.p. Maximum Pull at 2 5 ft./sec., 2,240 lbs. = 10·2 d.b.h.p. Stalling Load = 2,470 lbs.

Remarks.—The condition in the firebox which enabled these maximum Loads to be obtained lasted for 20 minutes only under test with each filling.

The results of the no-load tests have not been generally used in conjunction with the normal tests to give the fuel consumption per B.H.P. hour developed by the engine as the various consumption figures show the extent by which the fuel consumption varies. Under no-load conditions there is no indication that the fuel consumption per unit of work will be the same as at full load. In one instance only, was the result of the no-load test used. In the process of reaping and binding with small machines, the load was very light and the power required to drive the tractor formed a large proportion of the total output. In this case the result of the no-load test serves to show that there is not a considerable difference between the consumption at high and low loads. It can however be only taken as an indication and not as definite proof.

SERIES B.

Using high compression and steel wheels.

Pistons: Cast iron normal construction giving compression ratio 7.8 : 1.

Ignition Advance: 20° of engine crankshaft.

Steel Wheels: Standard Case designed fitted with:

(1) Powell Gas Plant.

(2) Herbert Gas Plant.

(3) Simplex Gas Plant.

SERIES B.—(1) POWELL GAS PLANT USING HIGH COMPRESSION AND STEEL WHEELS.

Date.	Time of Working.	Average Load.	Average Speed.	Average Draw-bar.	Time on Petrol.	Petrol.	Used	Area Worked.	Fuel Used: Total	Fuel Used: Per d.b.h.p. hour.	Fuel Used: Per acre.	Water Used: Total	Water Used: Per d.b.h.p. hour.	Water Used: Per lb Fuel	Remarks.
	min.	lbs	ft /sec	H.P.	min	lbs	gals	acres.	lbs	lbs	lbs.	lbs.	lbs	lbs.	
(a) Ploughing—19-9-38	255	720	4·29	5·5	8	4		3·85	157·0	6·7	40·75	4·25	0·1815	0·0275	Back-firing occurred when more water was used.
23-9-38	95	710	2·76	3·66	6			3·0	3·9	7·1	15·3	1·5	0·273	0·0385	Work very shallow.
(b) No Load—22-9-38	135		4·67		4	10·5		570 ch.	41·0	18·25 lbs./hr.		13·0	5·78 lbs./hr.	0·317	Lugs not bedding into ground.
15-10-38	142		4·63		5			597 ch.	42·0	17·73 lbs./hr.		10·0	4·22 lbs./hr.	0·238	Lugs not bedding into ground.
(c) Max. Load—27-1-39	73	Max. Load 986 lbs. at 5·1 ft./sec.=8·3 d.b.h.p							Max. Pull 1,120 lbs at 3 ft./sec. = 6·1 d.b.h.p.						Stalling load = 1,344 lbs.
		(2) HERBERT GAS PLANT.													
(a) Scarifying—7-11-38	293	950	4·02	6·95	8			11·28	137·5	4·06	12·2	8·0	0·236	0·0582	
(b) Max. Load—7-11-38		Max. Load, 1,365 lbs. at 4·16 ft./sec. = 10·33 d.b.h.p							Max. Pull 1,345 lbs at 3 ft./sec. = 7·35 d.b.h.p.						Stalling load = 1,590 lbs.
25-11-38		Max. Load, 1,120 lbs at 5·15 ft. sec. = 10·5 d.b.h.p													Stalling load = 1,570 lbs.
		(3) SIMPLEX GAS PLANT													
(a) Max. Load—23-1-39	58	Max. Load at 4·2 ft./sec., 1,120 lbs. = 8·55 d.b.h.p													Stalling load = 1,350 lbs.

SERIES C.—USING LOW COMPRESSION AND RUBBER TYRES.

Pistons—Standard as supplied by tractor makers for use with Kerosene. Cast Iron—Compression ratio 3·8 . 1. Ignition Advance—45° of engine crankshaft. Plugs—K.L.G. PKA. 3. (1) Powell Plant. (2) Herbert Plant. Cultivating only was done with this equipment.

Date.	Time of Working.	Average Load.	Average Speed.	Average Drawbar.	Time on Petrol.	Petrol Used.	Area Worked.	Fuel Used.			Water Used.			Remarks.
								Total.	Per d.b.h.p. hour.	Per acre.	Total.	Per d.b.h.p. hour.	Per lb. Fuel.	
(1) POWELL.														
	min.	lbs.	ft./sec.	H.P.	min.	lbs.	acres.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
(a) Cultivating—														
8-2-39 ..	200	1,130	4·09	8·4	15·0		7·85	82·75	2·95	10·54	12·0	0·428	0·145	
9-2-39 .	247	1,240	4·13	9·31	8·0	5·0	9·76	111·0	2·9	11·37	19·75	0·515	0·219	
(b) Max. Load— 8-2-39 .	Max. load 1,625 lbs. at 4·15 ft./sec. = 12·25 d.b.h.p.							Max. Pull 1,800 lbs. at 3·5 ft./sec. = 11·4 d.b.h.p.						
(2) HERBERT.														
(a) Cultivating—														
20-2-39 ..	310	1,355	4·1	10·1	12·0	.	12·2	139·0	2·67	11·40	10·5	0·2018	0·0755	
21-2-39	305	1,260	4·125	9·45	12·0	.	12·1	127·0	2·64	10·5	12·25	0·255	0·0965	
(b) Max. Load— 20-2-39 .	Max. load 1,700 lbs. at 4·06 ft./sec. = 12·53 d.b.h.p.							Max. Pull 1,850 lbs. at 3·0 ft./sec. = 9·81 d.b.h.p.					Stalling load = 1,960 lbs.	

SERIES D.—LOW COMPRESSION AND STEEL WHEELS.

Pistons: Standard Case Compression Ratio 3·8 : 1
Ignition Advance: 45° of engine crankshaft

Wheels: Standard Case fitted with spade lugs.
Plugs: K.L.G. PKA 3.

Date.	Time of Working.	Average Load.	Average Speed.	Average Drawbar.	Time on Petrol.	Petrol Used.	Area Worked	Fuel Used.			Water Used			Remarks
								Total	Per d.b.h.p. hr	Per Acre	Total.	Per d.b.h.p. hr.	Per lb. Fuel	
	min	lbs.	ft./sec	h.p.	min	lbs.	acres	lbs.	lbs.	lbs.	lbs	lbs.	lbs.	
						(1) POWELL PLANT								
(a) Cultivating—6-2-39	134	600	4·14	4·51	13	8	5·32	79	7·83	14·85	16·75	1·662	0·212	
(b) Maximum Load—7-2-39	75	Maximum Load 784 lbs. at 4·15 ft./sec. = 5·91 d.b.h.p.						Stalling Load = 900 lbs.						
						(2) HERBERT PLANT								
(a) Cultivating—22-2-39	65	615	4·6	5·15	6		1·19	Not taken			Not taken			
(b) Maximum Load—22-2-39		Maximum Load 616 lbs. at 5·03 ft./sec. = 5·63 d.b.h.p.						Stalling Load 728 lbs.						

GROUP II.

SERIES A—POWER AND CONSUMPTION TESTS USING KEROSENE.

Standard Pistons and Rubber Tyres.

Pistons: Stand Case compression ratio 3·8 : 1.
Fuel: Cross Power Kerosene.

Ignition Advance: 15° of engine crankshaft.
Tyres: Barnet Glass 4-ply, 11 25 x 24.

(a) Scarifying. (b) Maximum Load.

Date	Time of Working.	Average Load.	Average Speed.	Average Drawbar.	Time on Petrol.	Petrol Used.	Area Worked.	Fuel Used			
								Total.		Per d.b.h.p. hr.	Per Acre.
	min.	lbs.	ft./sec.	h.p.	min.	lbs.	acres.	lbs.	gals.	lbs.	lbs.
(a)—											
2-3-39	183	1,530	4·1	11 4	9	4·25	7·21	55·25		1·5	7·25
3-3-39	405	1,655	4·095	12 3	23	6·5	15·92	127·5		1·525	7 98
6-3-39	472	1,558	3·905	11·3	11		17·7	147 5		1·66	8 34
7-3-39 ..	219	1,420	3·87	10·0	12		7 78	60 5		1·657	7·77
(b)—											
4-3-39	Maximum Load 2,690 lbs. at 4·04 ft./sec., = 19 75 d.b.h.p.				Stalling Load = 3,250 lbs.						

SERIES B—STANDARD PISTONS AND STEEL WHEELS.

Pistons Standard Case Cast Iron Compression ratio, 3 8 1
Fuel: Cross Power Kerosene.

Ignition Advance 15° of engine crankshaft
Wheels Standard Case fitted with spade lugs.
(a) Scarifying. (b) Maximum Load

Date.	Time of Working.	Average Load.	Average Speed.	Average Draw-bar	Time on Petrol	Petrol Used		Area Worked.	Total		Per d b.h.p. hr	Per acre.	Remarks.
	min.	lbs.	ft. sec.	h.p.	min	lbs.	gals.	acres.	lbs.	gals.	lbs.	lbs.	
(a)—													
27-2-39	314	1,475	4 09	10 95	12	5·5		12·48	109·75	.	1 915	8 82	Lugs bedding well down.
28-2-39	373	1,330	4 21	10 18	10	6 5		15 1	111·5		1·765	7 38	Wheel rims riding ½in off ground on lugs
1-3-39	308	1,135	4 20	8 67	14			12 43	96 0		2·155	7·7	
(b)—													
1-3-39	Maximum Load 1,790 lbs at 4 25 ft./sec = 13 85 d.b.h.p							Stalling Load = 1,980 lbs.					

GROUP III.

SERIES A.—POWER AND CONSUMPTION TESTS AT THE BELT DRIVE.

Pistons: Cast Iron. Compression ratio 7.8 : 1.
Ignition Advance: 20° of engine crankshaft.

(a) Powell Gas Plant using Jarrah Fuel.
(b) Powell Gas Plant using Whitegum Fuel.
(c) Herbert Gas Plant using Whitegum Fuel.

Date.	Time of Working.	Engine Speed.	Brake Horse Power.	Cooling Water Outlet Temp.	Gas Temp. at Inlet Manifold.	Engine Suction at Inlet Manifold in Water.	Fuel Used.	Water Used.	Fuel per B.H.P. hr.	Water per B.H.P. hr.	Maximum Power Output.
A.—HIGH COMPRESSION PISTONS AND GAS.											
	min.	r.p.m.	lbs.	°C.	°C.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
(a) 20-5-38 ..	175	990.5	17.9	77.5	45	13.0	75.5	20.75	1.445	0.397	19.5
(b) 26-5-38 .	158	1,000.0	19.55	78.0	43	12.12	69.0	9.8	1.34	0.19	21.1
(c) 30-6-38 ..	165	1,000.0	17.6	77.0	51	19.3	67.25	8.5	1.39	0.1755	18.9
B.—STANDARD PISTONS AND KEROSENE FUEL.											
29-5-38	175	1,000.0	23.5	98.0	Not taken.	Not taken	27.1		0.93	.	24.18

LUBRICATION.

Samples of the lubricating oil were taken from the crankcase at regular intervals and were analysed by Messrs. D. Dodd and E. Jarvis at the University of Western Australia. The samples were taken after the engine had been working for at least an hour and usually with the engine running in order to obtain a representative sample.

Methods of Analysis.

(1) Specific gravity obtained by hydrometer at standard temperature.

(2) Viscosity by means of an Ostwald Tube in a bath at 130° F.

(3) Acidity.

(a) Titration mixture—To 25 mls. of alcohol were added 25 mls. benzol and 2 mls. of 2 per cent. alkali blue solution (alcoholic solution), then neutralised to a reddish tinge with NaOH solution.

(b) 50 mls. of the titration mixture were added to 10 mls. of oil and titrated against $\frac{N}{10}$ NaOH solution.

(4) Solid Content.

To 10 mls. of oil was added sufficient petroleum ether to extract the oil, then the minimum was centrifuged to separate the solids. The clear supernatant liquid was then poured off and the residue washed free from the oil by successive additions of petroleum ether followed by centrifuging and decantation. Subtracting the weight (A) of the clean centrifuge tube from the weight (B) of the tube and residue (after drying at 110° C.), the weight of total solids was obtained.

Washing the residue with benzol removed the asphaltenes (after repeated centrifuging and decantation). Subtracting the weight (C) of the dried tube and residue after this operation from the weight (B), the weight of asphaltenes was obtained.

The residue was then transferred to a weighed crucible, ignited, cooled and weighed. The loss of weight in this last operation represented the carbon content. The final residual was the ash.

To express the results obtained as percentages, the volume taken was multiplied by the specific gravity to give the weight of oil taken.

The results have been tabulated in four tables:—

(I) Using Powell Producer Plant.

(II) Using Herbert "Pioneer" Producer Plant.

(III) Using Simplex Producer Plant.

(IV) Using Kerosene Fuel.

Note.—In extracting the oil with petroleum ether, the supernatant liquid was dark in colour, indicating that the so-called tarry content of the oil was dissolved and not included in the total solid content.

TABLE I.

Time of Use. (hrs.)	Specific Gravity 28°C.	Viscosity. Ostwald Time at 130°F.	Acidity. (Concentration).	Percentage of— Total Solids.	Asphaltenes.	Mineral. (ash)	Carbon.
New Oil	0·882	193	0·0	0·0	0·0	0·0	0·0
10	0·880	197	0·002(N)	0·08	0·01	0·02	0·04
20	Insufficient sample	192·5	0·002	0·09	0·014	0·03	0·04
30	0·880	200	0·0024	0·07	0·015	0·035	0·02
40	0·881	189	0·0040	0·33	0·01	0·27	0·05
50	0·885	199	0·0092	0·37	0·01	0·30	0·07
60	0·888	223	0·016	0·49	0·02	0·34	0·12
80	0·892	262	0·031	0·4	0·03	0·25	0·15
120	0·894	280	0·044	0·5	0·04	0·4	0·1
147½	0·894	281	0·043	0·6	0·05	0·4	0·13
170	0·897	306	0·033	0·8	0·07	0·5	0·25
210	0·900	313	0·031	0·8	0·045	0·49	0·2

TABLE II.

Time of Use. (hrs.)	Specific Gravity 28°C.	Viscosity. Ostwald Time at 135°F	Acidity (Concentration).	Total Solids.	Asphaltenes	Mineral. (ash)	Carbon
New Oil.	0·882	139	0·0	0·0	0·0	0·0	0·0
25	0·893	167	0·0104	1·78	0·16	0·51	1·12
45	0·906	195	0·0144	3·22	0·42	0·92	1·89
60	0·908	199	0·0112	3·0	0·34	0·87	1·78
84	0·913	210	0·0104	3·53	0·43	0·99	2·12

TABLE III.

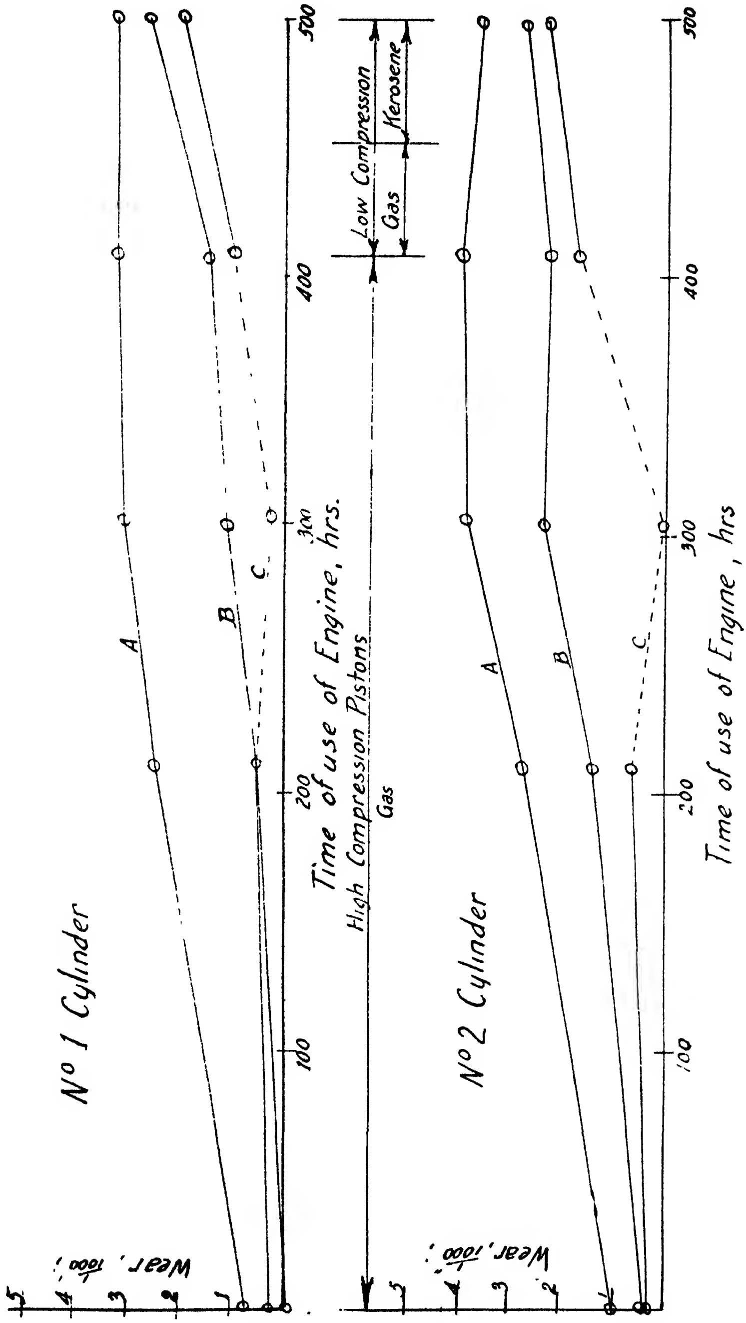
20	0·884	139	0·0100	0·42	0·12	0·15	0·16
40	0·889	156	0·0104	1·29	0·21	0·44	0·64
60	0·905	170	0·0060	3·08	0·13	1·17	1·78
80	0·910	168	0·0060	3·66	0·10	1·48	2·08
100	0·912	190	0·0096	5·69	0·88	1·69	3·13

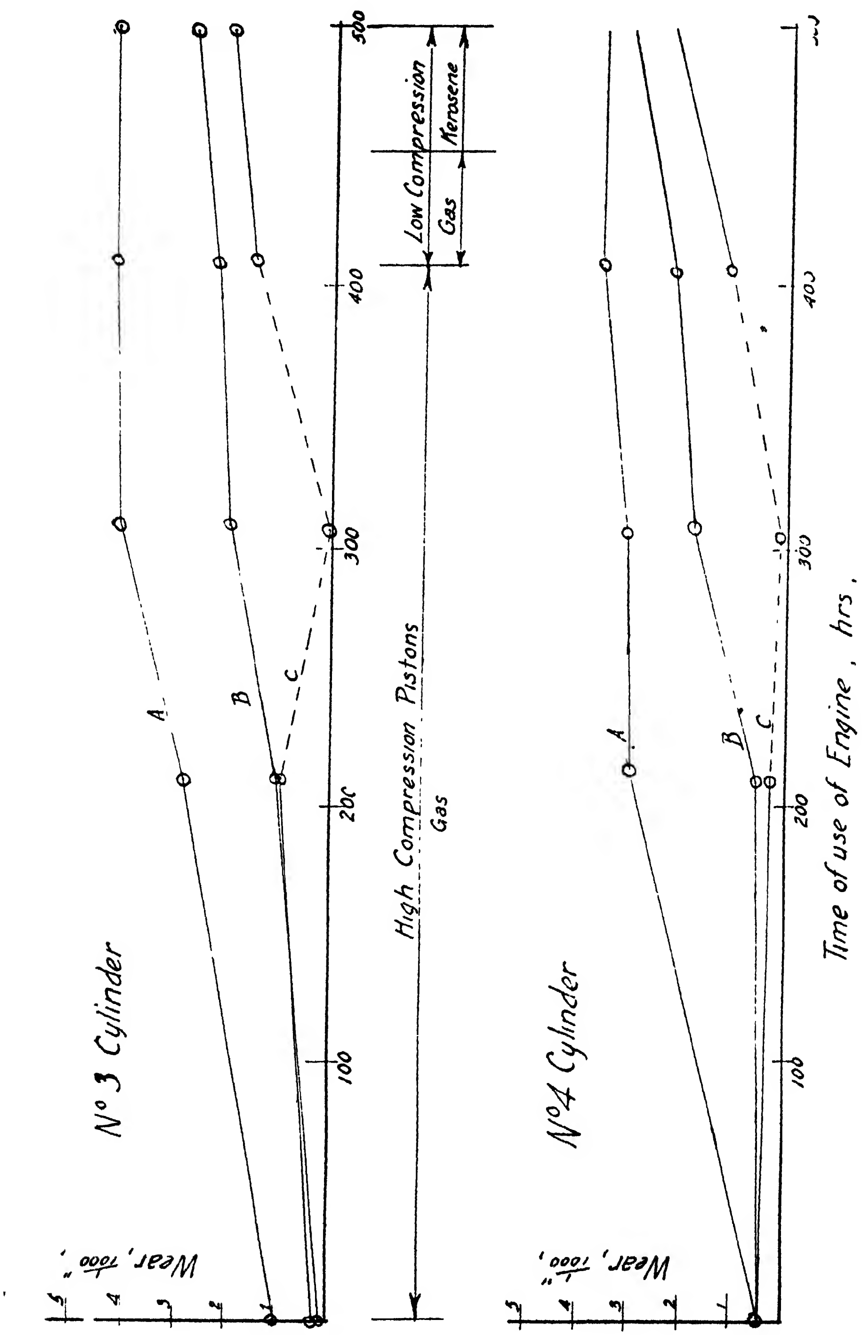
TABLE IV

10	0·881	82	0·006	0·156	0·02	0·088	0·046
20	0·880	86	0·006	0·154	0·01	0·100	0·044
30	0·880	76	0·002	0·172	0·03	0·098	0·044
15	0·878	60	0·005	0·192	0·03	0·120	0·042

The generally accepted quality of an oil that governs its ability to lubricate two surfaces in sliding contact is its viscosity. The higher the viscosity the better the lubricating qualities but also the greater resistance or drag of the oil. The reason why the oil from a kerosene engine has to be changed frequently is that the dilution of the lubricating oil by the unburnt fuel lowers its viscosity to such an extent that it becomes a poor lubricant. This dilution is entirely absent when gas is used as fuel and the tendency is for the viscosity to increase as the lighter portions of the oil are distilled off or burnt. For this reason, some other factor is to be sought to limit the time of use of the lubricating oil in a gas engine. The most generally accepted limit is when the solid content of the oil becomes sufficiently great to cause wear due to the abrasive action of the particles suspended in the oil.

The results of these analyses show how impossible it is to set down a time for the use of lubricating oil in an engine burning producer gas. Taking a solid content of 1 per cent. as a limiting value, it can be seen that in the first group, the oil was in good condition after 210 hours while in the second group it should have been changed after 20 hours.


No 1 Cylinder
No 2 Cylinder
Wear, 1/1000 in.
Time of use of Engine, hrs.
High Compression Pistons
Gas
Low Compression
Kerosene
A
B
C


No 3 Cylinder
No 4 Cylinder
Wear, 1/1000 "
A
B
C
100
200
300
400
500
High Compression Pistons
Gas
Low Compression
Gas
Kerosene
Time of use of Engine, hrs.

CYLINDER WEAR.

The cylinder barrel was measured with an Ames cylinder barrel gauge at the commencement of the series of tests, and after each type of producer plant had been tested and again after the engine had been run using kerosene as fuel.

The barrel was measured in three positions: At the bottom of the stroke; at the centre; at the top of the barrel. In each of these positions, the diameter was measured in four directions and the average taken as the mean diameter.

The results have been set out in the form of graphs, each cylinder being separated for the sake of clarity. The graph has as ordinates the diameter of the barrel expressed in 1/1000 parts of an inch above the nominal bore (4.125in.) and abscissae the number of hours working.

Remarks.

The readings taken after 306 hours were taken with the pistons out of the cylinder so that the reading at the bottom of the barrel is lower than it would have been if it had been taken at the same point as the others.

In cylinders Nos. 2 and 4 after the period of use with the low pressure pistons, the diameter at the top of the cylinder appears to have decreased. This could be accounted for by the fact that the piston rings of the low compression pistons do not wipe the top of the barrel and there was probably a film of carbon which could account for the errors of 0.4 and 0.2 1/1000 parts of an inch.

With the results presented in this form, the rate of wear with the relative equipments can be compared with ease. The irregularity of the results can only be explained by the fact that the periods were so short that the errors of measurement were almost as great as the actual wear.

Taking these results in conjunction with the results of the oil analysis, it tends to show that there is little relation between the rate of wear and the total solid content of the oil. For instance, the tests with the Powell plant show that the maximum solid content of the oil is 0.8 per cent., while for the Simplex plant it is 5.69 per cent. Without attempting to average the rates of wear in the four cylinders, it can be seen that throughout, the rate of wear with the Simplex plant is considerably slower than with the Powell plant.

In spite of the fact that the oil in the Powell plant was used for 210 hours, the rate of wear over the whole period does not vary considerably from that obtained by using kerosene fuel and changing the oil after 50 hours.

In light of such results of tests, it appears that the users of gas engines require some method of determining the lubricating qualities of an oil other than those that are in use at present.

ENGINE CONDITION AFTER EACH TEST.

The cylinder head was removed from the engine after the period of test of each plant and inspected. After the inspection, the combustion chamber was thoroughly cleaned and the valves reground preparatory to the next test.

The observations made on the cylinder head condition have been compiled in a brief form under the heading of the various component parts for the sake of comparison.

The subdivisions representing the condition after the period of test with—

(a) Powell Producer Plant .. .. 210 hours.
(b) Herbert Producer Plant .. .. 84 hours.
(c) Simplex Producer Plant .. .. 112 hours.
(d) Kerosene Fuel .. .. 45 hours.

(I.)—*Combustion Chamber.*

(a) Slight deposit of carbon on spark plug side of head cylinder walls coated with oil carbon above limit of movement of upper ring.

(b) Generally medimum carbon deposit heaviest in No. 1 cylinder least in No. 4. In each cylinder the heaviest deposit was on spark plug side of the head.

(c) Heavy oily carbon deposit piston crown having deposit 1/32in. thick —around the exhaust valves the scale showed white.

(d) Cylinder walls and head showed very hard deposit that tended to flake off. Average thickness 1/32in. thickest around the inlet valve reducing to a film near the exhaust valve.

(II.)—*Valves and Seats.*

(a) Inlet valve seats good. Manifold side of valve head covered with oily carbon which could be wiped off. Exhaust valve seats pitted: valve stems showed rusty white film which did not show signs of building up.

(b) Inlet valve seats good; manifold side of valve head had only a film of carbon. Exhaust valve seats pitted; stems showed rusty white film that could be wiped off.

(c) Inlet valve seats good; manifold side of valve head covered with soft dry carbon. Exhaust valve seats pitted; stems showed rusty white deposit.

(d) Inlet valve seats good; no deposit on manifold side of valve head. Exhaust valve seats pitted; valve heads showed rusty film.

(III.)—*Inlet Manifold.*

(a) Dry smeared with lamp black.
(b) Dry smeared with lamp black.
(c) Oily coated with fine carbon deposit.
(d) Clean.

(IV.)—*The Exhaust Manifold.*

Showed clean with (a). (b) and (c) having a white film. With (d), there was a black film.

(V.)—*Spark Plugs.*

(a) Clean porcelain; rusty coloured points burned
(b) Clean porcelain; rusty coloured points burned.
(c) Black porcelain covered with fine carbon; points burned.
(d) Black porcelain covered with fine carbon; points fair condition.

Remarks.

The condition of the combustion chamber in I. (b) was probably due to the condition of the engine big-end bearings which were slack. During the overhaul at the beginning of which this inspection was made, these were tightened, one

shim being taken out of each bearing. As the oil pump is situated at the same end of the engine as No. 1 cylinder, any slackness in the big-end would tend to cause No. 1 cylinder to obtain more than sufficient oil.

The condition of the exhaust valves and seats after the use of gas showed that the effect of the water in the products of combustion was to cause corrosion of the valve stems and pitting. The latter however had not reached serious proportions after 200 hours work, but it would have been inadvisable to work for longer without paying some attention to the valves.

COSTS.

The cost of working the tractor with which the tests were made was taken as far as possible from the observations made in the field. In seeking a method of presenting the costs in a method that admits fewest assumptions, the basis of draw-bar horsepower hours was adopted. This method permits the complete separation of the use of the tractor from the work it is doing. In order that these costs may be reduced to an average basis, observations were made on the drawbar horsepower hours required to cover one acre by various processes when the work was well done under average conditions. These figures are given at the end of the table of costs.

In arriving at the capital costs, the prices taken for the tractor wheels, gas plants, etc., were those ruling at the time of the tests. The prices of the various makes of gas plant vary, so the figure taken was that of a medium priced plant.

The costs for kerosene were based on the tractor working at its rated output. As the tractor was not rated for use with rubber tyres, an assumed rating was taken which allows the engine to run at its rated engine output with the same power loss between the belt pulley and the drawbar as occurs at maximum loads. With gas as fuel, there is no rated output so that the figures taken as possible working loads, are those that were maintained and appear as averages over a day's working. These are of necessity lower than the maximum.

The fuel consumption for gas varies with the make of plant. In order not to complicate the issue by giving the working costs with each plant fitted, a general value was taken which with some plants can be consistently bettered while with others it represents a fair average value.

The usual method of presenting working costs of a tractor is to assume a certain number of hours' working during the year, and divide up the costs on a time basis. In order that these results may be conveniently compared with others, a table has been made out for the working costs for 120 days work at 10 hours a day at the rated output of the tractor. Another, and it is hoped, a more useful table is drawn up assuming the same amount of work to be done by the tractor with the various equipments. Such a table gives the true comparison of cost of working a tractor under similar conditions when a definite amount of work has to be done.

To facilitate comparison the costs have been put in table form with the items noted as pounds per annum, and then having been totalled, transferred to pence per draw-bar horsepower hour. The table has been made into columns under headings as follows:—

(a) Kerosene fuel. Rubber tyres rated output 16 h.p.

(a') Kerosene fuel. Rubber tyres rated output 12 h.p.

(b) Kerosene fuel. Steel wheels rated output 12 h.p.

(c) Producer gas fuel. Rubber tyres, high compression pistons, oversize cylinder sleeves. Rated output 16 h.p.

(d) Producer gas fuel. Rubber tyres. High compression pistons. Rated output 13 h.p.

(e) Producer gas fuel. Rubber tyres. Low compression pistons. Rated output 9 h.p.

(f) Producer gas fuel. Steel wheels. High compression pistons. Oversized cylinder sleeves. Rated output 12 h.p.

(g) Producer gas fuel. Steel wheels. High compression pistons. Rated output 8. h.p.

(h) Producer gas fuel. Steel wheels. Low compression pistons. Rated output 4 h.p.

Basis for Estimating Costs.

Cost of Tractor: Reconditioned fitted with steel wheels, £230. Reconditioned fitted with rubber tyres, £290.

Cost of producer plant, £90.

Cost of high compression pistons, £8.

Cost of oversized sleeves with H.C. pistons, £15.

Interest taken as 6 per cent. on half the capital cost.

Depreciation: The useful life of the rebuilt tractor being taken as five years. The life of the gas plant being taken as that of the tractor.

Repairs: 40 per cent. of the capital cost divided evenly over the life of the tractor.

Labour: 14.5 pence per hour.

Kerosene: 1s. 3d. per gallon.

Petrol: 2s. per gallon.

Lubricating Oil: 5s. 6d. per gallon.

Charcoal: £2 10s. per ton.

TABLE I

1,200 working hours per annum.

Fuel	Kerosene.			Gas.					
Wheels	Rubber		Steel.	Rubber.			Steel.		
Pistons	L.C.		L.C.	H.C. Pistons.		L.C. Pistons.	H.C. Pistons.		L.C. Pistons.
Bore	Normal		Normal.	Over-size	Normal Bore.	Normal Bore.	Over-size.	Normal Bore.	Normal Bore.
Item	a.	a'.	b.	c.	d.	e.	f.	g.	h.
Overhead	89·9	89·9	71 3	122·4	120·28	117·8	103·85	101·95	99·2
Labour	72·5	72 5	72·5	72·5	72·5	72·5	72·5	72·5	72·5
Fuel	204·0	183·0	204·0	60·6	44·8	44·8	60·6	44·8	44·8
Petrol	10·5	10·5	10·5	9·18	9·18	9·18	9·18	9·18	9·18
Lubricating Oil	26·4	26·4	26·4	8·8	8·8	8·8	8·8	8·8	8·8
Total £ p.a.	403·3	382·3	384·7	273·48	255·56	253·08	254·93	237·28	233·48
Work done d.b.h.p. hr.	19,200	14,400	14,400	19,200	15,600	10,800	14,400	9,600	4,800
Cost: Pence d.b.h.p. hr.	5·04	6·37	6·41	3·41	3·93	5·63	4·25	5·94	11·68

TABLE II.

12,000 d.b.h.p. hours per annum.

Item	a.	a'.	b.	c.	d.	e.	f.	g.	h.
Overhead	89·9	89·9	71·3	122·4	120·28	117·8	103·85	101·95	99·2
Labour	45·3	60·5	60·5	45·3	55·8	72·5	60·5	90·6	182·2
Fuel	132·0	119·0	166·5	34·6	34·6	42·0	75·0	75·0	105·0
Petrol	6·56	8·75	8·75	5·73	7·06	10·2	7·65	11·5	23·0
Lubricating Oil	16·5	22·0	22·0	5·51	6·76	8·8	7·35	10·98	22·0
Total £ p.a.	290·26	300·15	329·05	213·54	224·50	251·3	254·35	292·03	431·4
Cost: Pence d.b.h.p. hr.	5·82	6·0	6·58	4·26	4·49	5·03	5·08	5·83	8·61

TABLE III.

Work per Acre of Various Processes under Conditions of Test.

Ploughing (mouldboard) 6in. deep	10·6	d.b.h.p. hrs.	per acre
Scarifying 6in. deep	4·94	do.	do.
Cultivating 3in.–4in. deep	3·5	do.	do.
Harvesting (Crop, 4 bags per acre)	2·98	do.	do.
Binding	1·98	do.	do.

Column a' has been included as it serves to show the working costs of the tractor if the same implements are used after a tractor has been fitted with rubber tyres as when fitted with steel wheels.

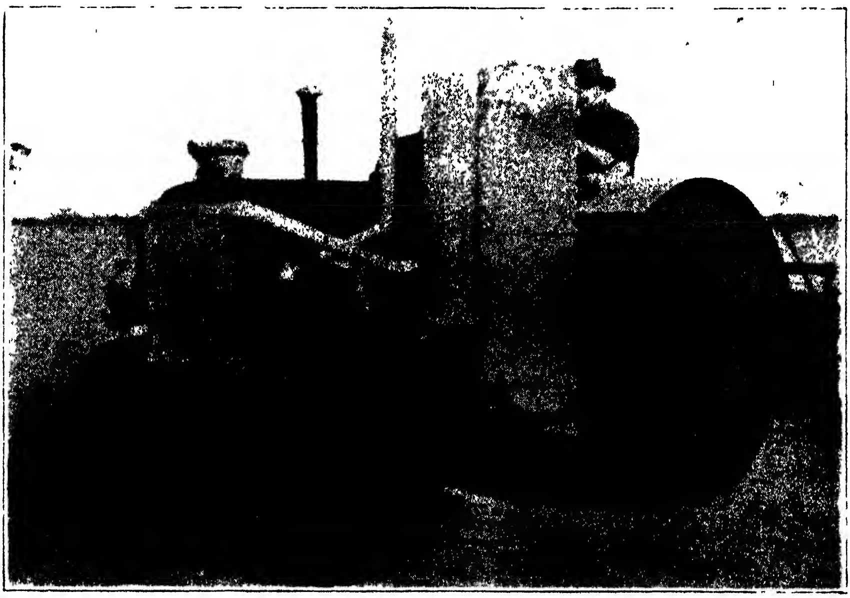
The position illustrated by these figures is then that, if a farmer is using a tractor burning kerosene and fitted with steel wheels, by making an outlay of £80 to fit the plant with rubber tyres, he can cut his costs by £28.9 per annum. If he now buys a complete set of implements, he can cut his costs by a further £10 per annum. However without buying a new set of implements but fitting a gas producer with high compression pistons he can cut his costs by a further £75.65 per annum, so that at the end of the year, the saving due to reduction in working costs is £104.55 with only an outlay of £178 which is earning interest at 7 per cent.

With an outlay of £100 it is possible by using a gas plant with high compression pistons and oversize barrel, yet with steel wheels, to reduce the working costs by £74.7 per annum.

For the farmer who is already working his tractor on kerosene and using rubber tyres, the outlay of £100 that covers the cost of high compression pistons and oversize sleeves as well as the gas plant, enables him to reduce the working costs by £76.72.

Block 11

The Allis-Chalmers "LL" Tractor.



Block 12.

"ALLIS-CHALMERS" TRACTOR TESTS.

Name and Model of Tractor: Allis-Chalmers "U."

Manufacturer: Allis-Chalmers Manufacturing Company, Milwaukee, U.S.A.

Manufacturer's rating: Kerosene fuel: Engine 31 h.p. Drawbar: Steel wheels 23. Rubber wheels not rated. Gas fuel not rated.

Brief Specifications: Motor own make. Serial No. 17354. 4-cylinder vertical; perpendicular head; mounted crankshaft lengthwise. Bore and stroke 4½in. x 5in.; rated engine speed 1,200 r.p.m., fitted with special pistons giving compression ratio 6.5:1. Ignition: Scintilla-Bendix magneto.

Gas Plant: Herbert "Pioneer." Updraught welded mild steel double shell; drip water feed, manual control; scrubbers, one dry one followed by one oil scrubber and dryer. Cooler multiple tube type situated in front of engine radiator.

Chassis: 4-wheel type. Serial No. U15097. Two driving wheels. Enclosed gear drive.

Advertised speeds, miles per hour: First = 2.33, Second = 3.33, Third = 5.0, Fourth = 11.75, Reverse = 2.67.

Rubber-drive wheel tyres 12.75 x 28 inches. Air pressure 16 lbs. Water filled 360 lbs. tyre. Front tyres 6.00 x 16; air pressure 24 lbs.

Weight of plant: Weight of tractor with operator, 5,476 lbs.; weight of producer plant, 336 lbs.

Fuel: White gum charcoal ex Chidlow, Western Australia. Retort burned.

Lubricating oil: Shell motor oil S.A.E. 40. 3.73 gals. in the engine; oil drained at end of test. Total time of test, 69.5 hours.

Repairs and adjustments: The spark setting was advanced 10° of the engine crankshaft from the normal.

Remarks: The tests were carried out under field conditions; where the load was not constant, the results are based on averages. The maximum load test was based on maximum loads with the load and speed checked over half minute intervals. Maximum observed draw-bar horsepower was 26.5.

The tractor was worked at its third gear speed as the dynamometer was not designed to transmit loads that could be obtained at lower speeds.

The method of observing the speed and load was similar to that used in the tests on the "Case" tractor.

Tests carried out were:—

(a) Scarifying with 16 tyne scarifier. Depth of cut 6-8in.
(b) Cultivating or discing with 14 disc sundercut plough. Depth of furrow 5-7in.
(c) Maximum load tests.

Remarks.—The tractor supplied was fitted with sleeves having 4½in. bore which is standard for all similar tractors supplied in Western Australia. The tractor tested for the Nebraska tests however was fitted with 4⅜in. bore.

Remarks.—The speed of the tractor when using gas is appreciably lower than the advertised speed for kerosene fuel. This drop in speed is noticed as soon as the load becomes more than half the maximum that can be taken. This drop of speed may be overcome by advancing the magneto timing, but the maximum variation that could be made without interfering with the gear timing was used with very little effect. In order to obtain the maximum power output, the governor was set full open with the heavy load applied. With the governor set to limit the engine speed to 1,200 r.p.m. the maximum horsepower output at the drawbar was 22.4.

"ALLIS-CHALMERS" TRACTOR TESTS.

Date.	Time of Working.	Average Load.	Average Speed.	Average Draw-bar.	Time on Petrol.	Petrol Used.		Fuel Used.			Water Used.			Remarks.
								Total.	Per d.b.h.p. hr.	Per acre	Total.	Per d.b.h.p. hr.	Worked.	
	min.	lbs.	ft./sec.	h.p.	min.	lbs.	gals.	lbs.	lbs.	lbs.	lbs.	lbs.	acres.	
(a)—														
18-10-38	170	1,800	6·7	21·9	20	6 0		177	Not checked					
19-10-38	139	1,460	7·3	19·45	20	5·75		64	,,	,,				
20-10-38	366	1,435	6·28	16·4	6			137	1·37	12·77	Not checked		10·72	Air leak in gas line stopped.
21-10-38	195	1,570	5·4	15·5	8			98·5	1 695	17·01	23	0·457	5·79	
28-10-38	354	1,500	6·41	17·5	12	5·5		272	2·65	22·2	23	0·204	12·22	
29-10-38	507	1,540	5·5	15·4	11	3 25		218	1 677	17·65	Not checked		12·33	Ploughing 8 furrow, mouldboard.
(b)—														
19-12-38	289	1,270	6 67	15·4	10	Not checked		297			34		17·2	
20-12-38	315	1,300	6 6	15 6	23	..	..	138	2 08	8 89	10	0 213	18·75	
21-12-38	260	1,290	6·7	15 5	18	..	..	120			34		15·5	
22-12-38	300	940	7·25	12·4	14	..	,,	62			—17		17·85	Water removed from tank at end of period.
3-1-39	265	1,300	6·6	15·6	12	,,	,,	195			72		15·8	
4-1-39	363	1,320	6 65	15·98	16	..	,,	177	1·72	7·53		0 221	21·65	
5-1-39	265	1,270	6·7	15·49	11	,,	..	126			21		15·8	
6-1-39	380	1,290	6·4	15·0	8	..	,,	73			—22		22 6	
(c)—														
20-10-38	Maximum Load 2,580 lbs. at 5 65 ft./sec. = 26·5 h.p.							Maximum Pull 2,700 lbs at 4 5 ft /sec. = 22·1 h p.					Stalling Load = 2,800 lbs	

Engine Condition after 69.5 hours' Work.

(1) *Combustion Chamber.*

Generally clean. A wipe with a rag left bright metal showing. A ring of carbon deposit was formed around the outer edge of the top of the piston which diminished to nothing at the centre of the piston. At the edge, this ring was approximately 1/32 of an inch thick. The deposit showed a tendency to lift away.

(2) *Valves.*

Valve seats were slightly pitted. The exhaust valves generally were pitted while the inlet valves showed marks that could be removed by a rub with grinding paste. The manifold side of the inlet valves was covered with a light coat of lamp black that could be wiped off with a rag. The exhaust valves had a harder deposit, which was a rusty white colour, part of which could be rubbed off with cloth but the majority of which required scraping to remove it.

(3) *Cylinder Wear.*

The measurements of the cylinder barrel were not taken before the tests were made so that no absolute record of the wear is available. The engine was almost new before the tests having been run enough to run it in. Measurements were made after the tests with an Ames cylinder barrel gauge with the instrument set at zero for the nominal base of 4½in.

The readings were taken in two directions:—

(a) Parallel to the crankshaft.
(b) At right angles to the crankshaft.

The gauge was placed at the bottom of the barrel and moved up the cylinder,—the first reading being that at the bottom of the cylinder and the second, the maximum divergence from it, which usually occurred ¾ of an inch from the top. All readings are in 1/1000 parts of an inch.

	a	b
No. 1 cylinder:	-1½ to 1	1 to 0
No. 2 cylinder:	—2½ to —2½	1 to 1
No. 3 cylinder:	— 2½ to —2	½ to 0
No. 4 cylinder:	—2 to —1½	2 to 0

Working Costs using Allis-Chalmers Tractor with Producer Gas as Fuel.

Cost of tractor new fitted with Herbert Gas Plant: £575.

Cost per annum assuming 24,000 d.b.h.p. hours per annum:

Overhead:	
Interest 6% on half capital	17.25
Depreciation for 8 years life	71.87
Repairs and maintenance 40% of capital over life	28.73
	£117.85
Labour: 14.5 pence/hr. for 1,200 hours	72.5
Fuel: 1.9 lbs./d.b.h.p.hr. @ 0.3 pence/lb.	57.
Lubricating oil: 3.75 galls. every 150 hours @ 5s. 6d. gallon ..	7.5
Petrol	8.37
	263.22

Cost per d.b.h.p. hr. = 2.63 pence.

Therefore cost of scarifying to a depth of 6 inches on normal land, using figures previously quoted 2.63 x 4.94 = 13 pence per acre. Similar costs for the

same tractor using kerosene and equipped with rubber tyres can be calculated from the results of the Nebraska Tests.

Overhead Costs:—

	£	£
Interest	14.85	
Depreciation	62	
Maintenance	24.8	
		101.65
Labour 14.5 pence/hr. for 1,200 hours		72.5
Fuel 0.82 lbs./d.b.h.p. hr. @ 1.75 pence/lb.		143.5
Petrol		8.42
Lubricating oil: 3.75 galls. every 50 hours @ 5s. 6d. gall. ..		24.75
Therefore cost /d.b.h.p. hour 3.5 pence.		£350.82

Cost of scarifying: 17.35 pence/acre.

Time and Labour Entailed in Preparing a Tractor for Work.

Throughout the tests, a check was kept on the time required to prepare the tractor for work. The total time was noted from the time the driver was ready to commence work till the time the tractor was actually drawing the implement for the time required to start work, and if the driver elected to do any draining or other servicing when he stopped work, the time taken was noted from the time the tractor stopped working to the time the driver stopped work.

This check involved including the time taken for all measurement of quantities of fuel, etc., that were made. In order to obtain a time that was free from procedures that were purely for test purposes, the time required for each procedure was noted.

A.—Time involved during the working day in servicing a tractor fitted with a Producer Gas Unit.

(a) *Morning.*—Selecting and weighing sufficient charcoal for 9 hours work .. .. 10 min.
Cleaning out and weighing residue in generator .. .. 10 min.
Fill generator with fuel and cleaner with oil .. .. .. 5 min.
Weigh and pour into tank sufficient water .. .. .. 5 min.
Top up radiator, starting engine and changing on to gas .. 6 min.
Greasing tractor .. .. 8 min.

Total .. .. 44 min.

(b) *During the Day:*

Morning:
Fill generator after 2½ hours from bag carried on tractor or implement .. .. 4 min.
Stop for lunch allowing tractor to idle .. .. .. 2 min.

Afternoon:
Refill generator and start .. .. 6 min.
Refill generator from bag carried on tractor or implement 4 min.
Stop in evening with engine idling .. .. 2 min.
Drain oil from scrubbers .. .. 2 min.
Draining and weighing water .. .. 4 min.

Total .. .. 24 min.

Total time taken in a day—1 hour 8 minutes.

B.—(a) Making no allowances for time of weighing and cleaning generator once a week:

Filling generator and selecting day's supply of fuel	8 min.
Filling cleaner with oil	4 min.
Filling tank and radiator with water	4 min.
Greasing tractor	8 min.
Starting up and changing over	6 min.
	30 min.
(b) During the day as before	24 min.
Total	54 min.

C.—(a) Using kerosene fuel:

Weighing and pouring into tank day's supply of fuel	10 min.
Greasing	8 min.
Starting engine and warming up on petrol	10 min.
Filling up radiator	2 min.
	30 min.
(b) During the day:	
Stopping for lunch, drain kerosene out of carburettor	3 min.
Starting and changing to kerosene	5 min.
Topping up radiator	3 min.
	11 min.
Total	41 min.

The time required to weigh the kerosene was 2 minutes, so that in practice the total time required is 39 minutes. In all the increase of servicing time can be considered to be 25 minutes. This can be materially reduced when an attempt is seriously made, but to allow the work to be done efficiently without undue hurry, the times given which are averaged over a long period and then given to the nearest minute are those that may be reasonably expected.

The servicing time with a producer plant fitted can be materially reduced with two men working. It is possible to work without undue haste and have the tractor working 25 minutes after the men commence work in the morning. Thus if a second man gives assistance for 25 minutes a day, the time can be reduced to that required for servicing a kerosene tractor.

Compared with this under test conditions, one man performed the whole task of preparing the tractor for work in the morning in 26 minutes from the time he commenced work to the time he started the farming operation he had to do. Also the time required to refuel during the day was several times only 2 minutes from the time the tractor stopped to the time it began under load. To keep to this time requires that the engine is not stopped and the only way to refuel without stopping the engine is to be quick.

A further observation that was made throughout the tests was the weight of dust collected in the cleaners each day. For the purpose of power and consumption figures, these observations are useless. The dust so collected is too fine to be of any use and is therefore waste. It is not possible to subtract this from the

fuel used when calculating the consumption figures. From the point of view of design of dry cleaners, however, it is of considerable interest and value. When testing a cleaner, it is very advantageous to know at what speed the dust has to be fed in so that conditions may approach working conditions. Similarly in the design; if the approximate rate of collection of dust is known, the capacity of the collection chamber can be designed so that it will just be full at the time of empyting, thus doing away with unnecessarily cumbersome cleaners.

The figures obtained vary according to the load and in some cases appear to be very irregular. The general value however can be arrived at as follows:—

Powell Plant—0.3 lbs./hr. for light loads extending to 1.3 lbs./hr. for heavy loads.

Herbert "Pioneer" Plant—0.7 lbs./hr. for light loads increasing to 2.0 lbs./hr. for heavy loads.

"Simplex" Plant—0.25 lbs./hr. for light loads increasing to 0.4 lbs./hr. for heavy loads.

The very low rate of dust collection in the "Simplex" is due to the fact that the gas is taken from the generator above the surface of the fuel, with the result that there is a large capacity settling space before the first cleaner, so decreasing the amount of dust taken over with the gas.

With the Herbert "Pioneer" and "Powell" generators, however, the take-off is similarly situated in the fuel bed, and if anything, the larger take-off area of the Herbert should cause less coarse dust to be held in suspension.

Taking the efficiency of the Herbert cleaner as 60 per cent., the rate of dust flow in the gas varies between 1.165 and 3.33 pounds per hour according to the load.

The efficiency of the Powell cleaner is then 39 per cent. at high loads and 25.8 per cent. at low loads.

It was impossible to separate the oil from the dust collected in the oil scrubber sufficiently to estimate the amount of dust collected in it, so that a check on the total solids in suspension in the gas is not possible. However the figure of 60 per cent. efficiency was obtained by a Herbert dry cleaner when tested at the University of Western Australia, under conditions similar to those met with in practice.

Theoretical Aspects in the Design and Use of Producer Gas.

Calorific Value of Fuels.—The calorific value of the air-fuel mixture when a petroleum fuel is used which has a calorific value of 20,000 B.Th.U. per lb. is 104.5 B.Th.U. per cubic foot.

In comparison the calorific value of the air fuel mixture when producer gas is used, varies between 65 and 82.2 B.Th.U. per cubic foot, depending on the efficiency of the producer. In a plant that is working with practically no heat loss, and is employing the sensible heat of the gases, leaving the generator to preheat the water, it is possible to generate a gas which will give a mixture of calorific value of 82.2 B.Th.U. per cubic foot. In such plants where this ideal condition does not hold and the sensible heat of the gas is wasted in coolers, the maximum calorific value of the mixture is 79.1 B.Th.U. per cubic foot. A more practical figure is that when the total heat losses are 10 per cent., i.e., the generator is working at a 90 per cent. overall efficiency; a condition which has frequently been obtained in practice, the calorific value of the air-fuel mixture is then 77.2 B.Th.U. per cubic foot.

Thus from consideration of the calorific value of the fuels, the maximum power output with gas as fuel is 74 per cent. that of kerosene.

Compression Ratio.—An engine using kerosene tends to develop pinking or detonation when the compression ratio is raised above 4:1. When gas is used as fuel, such a phenomenon does not occur.

In arriving at the maximum compression ratio at which it is possible to operate an engine burning producer gas, the sole limiting fact is the temperature of spontaneous ignition of a mixture of Hydrogen, Carbon Monoxide, Carbon Dioxide, and Nitrogen Gases. K.G. Falk (Journal Amer. Chem. Soc., 1907) obtained the value of 550° C. to 620° C. for such a mixture depending on the exact proportions. These values were obtained by the method of instantaneous compression, a method which has since been proved inaccurate, but which serves to show the limiting compression ratio admirably.

Accepting the lower value of 550° C. for the purpose of general work, it is then possible to calculate the maximum possible compression ratio.

Taking the equation for adiabatic compression $\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\gamma-1}$

and assuming the initial temperature to be 60° F. the limiting compression ratio is 13.5:1. However, with an initial temperature of 170° F., which is the temperature of the cooling water, the maximum compression ratio is reduced to 8.6:1.

The air standard efficiency of an engine using a compression ratio of 8.6:1 is 57.5 per cent. Compared with this, the air standard efficiency of an engine using a compression ratio of 4:1 is 42.5 per cent.

Assuming that an engine works at 50 per cent. of its air standard efficiency, we have then that a gas engine burning a fuel air-mixture of 77.2 B.Th.U. per cubic foot at 28.7 per cent. efficiency delivers 22.1 B.Th.U. per cubic foot of mixture used. A kerosene engine however burns a fuel air-mixture with a calorific value of 104.5 B.Th.U. per cubic foot at an efficiency of 21.25 per cent. and delivers 22.2 B.Th.U. per cubic foot of mixture used. The possible power output of an engine so modified for the use of gas is then 99.6 per cent. of the power output when using kerosene.

In order to obtain full benefit of this, it is necessary to have an engine with the combustion chamber designed to give the greatest possible heat conduction, so that the temperature of the incoming charge before compression is as low as possible. Without good heat conduction, pre-ignition is capable of causing a greater loss of power than can be hoped to be obtained with the increased compression ratio.

Dimensions of the Generator.—In the tests conducted, there was very little variation in the size and design of the generators, the essential difference between the Herbert and the Powell producers being that the former had an effective flame path length of 13½ inches while the latter had a flame path length of 18 inches. The diameters are very nearly the same. In the laboratory tests under steady conditions, the plant with the longer flame path gave a higher maximum power output. While in variable field conditions, the plant with the shorter flame path gave the higher power output. Under all conditions, the fuel consumption of the plant with the shorter flame path was the lesser. These results show that

there is a certain amount of reversal of the action by which carbon monoxide is formed, when a long time of contact is used with the consequent formation of a gas rich in hydrogen and containing carbon dioxide.

It is possible to reap the benefit of this effect in the use of a stationary plant with steady load conditions, but in a mobile unit with variable load conditions such as are met in field work, it is impossible to maintain the fire in a sufficiently stable state to allow the greatest benefit from the use of the exact quantity of water to be obtained.

CONCLUSION.

From the results of the tests which have been presented in this report, it can be seen that the use of a cheap fuel similar to producer gas is a very real method for a farmer to cut his working costs. The results of the power and consumption tests show that the maximum horsepower at the belt is 87.4 per cent. of the kerosene output while the maximum output at the drawbar is 77 per cent. Thus there is a definite loss of power with the engine used. In spite of this loss of power with the present prices of fuel oil, labour and tractor, the working costs show that a tractor equipped with producer gas and high compression pistons can operate at 77 per cent. of the cost per drawbar horsepower of a kerosene tractor equipped with rubber wheels. With the modern tractor the costs are considerably reduced, but the gaseous fuel shows an advantage of 25 per cent. over the kerosene tractor.

The series of tests conducted were designed primarily to obtain definite figures for the use of gas on farms in place of kerosene. The merits and demerits of the use of such a fuel for transport with cars and trucks have not been investigated in this instance. In the average car, the greater proportion of the running costs is made up of the overhead expenses. Compared with this, however, the price of fuel is 2.34 pence per pound for petrol, and 0.3 pence per pound for charcoal. If then the weight of fuel consumed per mile were double that when using petrol, the fuel costs would be divided by four when gas was used. This should more than compensate for the increase in the capital cost.

In calculating the cost of lubricating oil for the tractor, it was assumed that the oil would be used for three times as long when using gas as when using kerosene. This is purely an assumed figure as the engine was operated up to 210 hours or four times the normal period without change of oil, yet no apparent damage was done. For this reason, it is very difficult to give a definite figure for the life of the lubricating oil, but 150 hours is considered sufficiently conservative to enable the engine to give the maximum work with the minimum expense. Such a figure must always be limited with a proviso that the cleaning system be in good condition.

When dealing with the theoretical aspects of the production of producer gas it was shown that with a well designed generator that gave a good quality gas, it was possible by raising the compression ratio of a kerosene engine to obtain almost the same power output as with kerosene without further modifications. To obtain such results, a very cool running engine is required.

In all, the use of a tractor equipped with a producer gas generator for a period of six months under test conditions showed that the plants tested were suitable for use on a farm without further alterations.

Cleanliness in Dairy Routine.

A. L. HAMILTON, Dairy Adviser.

Much has been written on "cleanliness" in the various phases of the production of top grade dairy products, *i.e.*, washing utensils, cleaning separators, milking machines and so on, and it will be readily admitted that this subject is of paramount importance to the dairy farmer who is paid according to grade for his produce.

This article has been written in an endeavour to include the most important sections of all these operations under the heading of "Cleanliness in the Dairy Routine."

Taking the various operations in order of their occurrence, the first point which warrants close attention is:—

Cleanliness of the Cow:

The hair of the coat and on the udder is a fruitful source of bacterial contamination when the cows come in from the paddocks. In the summer bacteria laden dust invariably exists on the hair, and in the winter when the cows are wet with rain or dew the drops of water contain many thousands of bacteria and are a source of contamination by undesirable types when the water is allowed to drop into the milking bucket.

It is recommended that a cloth which has been dampened with a dilute solution of potassium permanganate (Condy's crystals) should be used to wipe over the flanks and udder of the cow immediately prior to milking.

The first squirt of milk from each teat should be discarded for the reason that bacteria find their way into the teat from the exterior and multiply there between milkings.

Methods of Milking:

It is a well-known fact that so-called "wet milking" is definitely a contributing source of the bacteria in milk. A smear of petroleum jelly on the teats should obviate the necessity for wetting the milker's hands with milk and has the effect of keeping the teats in healthy condition.

Cleanliness and health of persons tending the cows, of course, is essential in the production of bacteriologically clean milk.

Cleansing of Separator and Utensils:

In cleansing the separator and dairy utensils three processes are necessary, any one of which is useless unless combined with the other two:—

(a) Washing with lukewarm water to remove the curdy sediment which, if left, will form upon subjection to heat an insoluble substance (milk-stone) which is particularly difficult to remove.

(b) Washing and scrubbing with scalding hot water containing washing soda or other recognised dairy cleanser.

(c) Sterilisation with steam. A simple steaming device for placing over a copper of boiling water is described in Leaflet No. 424 which may be obtained on request.

It may be said here that the growth of organisms from the time of washing and sterilising to the time of the next milking can be very great, and therefore considerable benefit can be derived by a second sterilising of all utensils immediately prior to milking with either steam or chemical sterilisers containing chlorine compounds. Chlorine disinfectants are marketed at present in powder form which is preferable to liquid chlorine disinfectants, as the powder is less likely to deteriorate in storage.

All utensils, after sterilising, should be placed on racks so that the metal surfaces dry out rapidly. Bacteria will multiply in the presence of moisture.

Cleansing the Milking Machine:

Probably the most fruitful source of bacterial contamination of milk on the farm is caused by lack of attention to the proper cleanliness of the milking machine, which is due to lack of knowledge on the part of the dairy farmer as to the most efficacious cleaning method or failure to dismantle the important units in the milk line as explained later.

The following method has given excellent results and is recommended to users of machines (see "Journal of Agriculture of W.A.," September, 1933, pages 385-391, i.e., "The Cleansing of Milking Machines," by M. Cullity, Agricultural Adviser, Dairy Branch):—

(1) Before milking draw cold water through all milk tubes and releaser, so as to prevent adhesion of milk to pipes, rubbers, etc.

(2) Immediately after milking, wash all the dirt off the outside of the teat cups and rubbers, then draw sufficient warm water through to flush out the milk system. When drawing the water through the set farthest from the releaser, insert a ball of horse-hair in the end of the milk pipe so that it will travel through to the releaser with the water. Withdrawing the horse-hair or brush with a cord recontaminates the pipes.

(3) Next draw through each set of teat cups not less than 1 gallon of boiling water to which has been added caustic soda at the rate of 1 to 1½ teaspoonsful per 4 gallons of boiling water. Distribute the solution as evenly as possible through each set of teat cups.

(4) Immediately follow by flushing out the caustic soda solution with 2 gallons of hot or 1 gallon of boiling water for each set of teat cups.

(5) Remove or open the plug or flap from the releaser pipe to allow of free circulation of air.

(6) Next clean the vacuum system in the same manner as the milk system by drawing through first the caustic soda solution and the boiling water which has been circulated through the milk system. Pay particular attention to the cleaning of the pipe connecting the releaser to the vacuum tank by flooding the releaser to cause the water to flow through to the vacuum tank. *This is important.*

(7) The engine can now be stopped. Disconnect the two long rubbers from downpipe and teat cups and hang in a clean dry airy place out of direct sunlight.

(8) Disconnect the releaser, wash, rinse and place in a clean dry sunny place, then disconnect the top or bottom half of the vacuum tank and treat in the same manner. To be successful *these operations*

must be carried out daily. This does not dispense with the necessity of dismantling the machine as often as possible so that all joints and crevices may be examined and treated.

The use of caustic soda in the method herein described does away with the use of brushes or scrapers which score or cut the inside rubber surfaces, so making irregularities which harbour fat and casein, etc., and support subsequent bacterial development, leading to heavy contamination.

It also is necessary to have yards, bails and surroundings in clean condition, in order to minimise contamination with dust, dung, etc. With this in view, compliance with the following conditions taken from the Health Act, 1911-1919, regulations has become necessary:—

(a) The floor of a properly constructed milking shed must be concrete or other impervious material and correctly drained into an open impervious drain at least 20 feet away from the shed.

(b) A milk and cream storage room must be built on approved lines with a concrete floor and properly ceiled and ventilated, also fly-proof, and be at least 10 feet from the milking shed.

(c) Provision must be made for boiling water to be available at the bails immediately adjacent to the washing up facilities in use.

(d) Cow bails and sheds must be lime-washed or painted with other suitable preparation. A 4-foot dado of tar or bituminous paint is recommended as being simple to wash down.

It may be said in conclusion that only a few cases of unsatisfactory milk or cream quality are traceable to any single source of origin, but most cases are due to a culmination of many small and seemingly unimportant foci of bacterial contamination which can only be eliminated by careful attention to detail, as outlined above, in every operation of the dairy routine.

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The Baking Quality of Wheat Fertilised with "Minor Elements" in Western Australia.

L. W. SAMUEL, Cereal Research Officer.

(1) *Introduction*:

The Department of Agriculture of Western Australia conducted a number of experiments on the use of "minor" elements on the growth and yield of wheat during the 1938-39 season. Samples of the grain from two of these experiments have been examined for baking quality by the "wholemeal fermentation time" test (Pelshenke test) and by the Brabender farinograph. Details of these two tests as used in this laboratory for the estimation of baking quality have previously been published. (Samuel, 1938.)

(2) *Materials*:

The wheat samples examined were from the experiments at—

(a) the Wongan Hills Research Station on sand-plain country, described by Teakle & Thomas (1939), and

(b) Wagin, on light lands ranging from gravelly sand-plain to a light sandy loam, described by Stewart & Teakle (1939),

and details of the soils, cultural treatments, field response and yield are given in the publications cited so that only essential details will be repeated in this paper.

(3) *Wongan Hills Research Station*:

Three series of 6 x 6 latin squares were used to explore the effect of fertilising with elements other than phosphorus. The wheat variety Nabawa was sown by hand and the fertilisers applied as complete mixtures to the same rows. Each plot was 48 inches long by 7 rows (49 inches) wide and the grain was harvested from one square yard from the centre of each plot.

(a) Each sample was subjected to the "wholemeal fermentation time" test and the results analysed statistically. The data are summarised in Table 1.

TABLE 1.

The baking quality, as judged by the "wholemeal fermentation time," of Nabawa Wheat fertilised with "minor" elements.

Treatment.	"Wholemeal fermentation time" (average). mins.
Series 1.	
Control—N + P + K	47
Control plus copper sulphate	49
Control plus manganese sulphate ..	47
Control plus borax	49
Control plus zinc sulphate	39
Control plus magnesium sulphate ..	47

Difference necessary for significance ($P = 0.05$) $= \pm$ 3 mins.

TABLE 1—*continued.*

Treatment.	"Wholemeal fermentation time" (average).
Series 2.	mins.
Control—N + P + K	49
Control plus ferrous sulphate	47
Control plus manganese sulphate and copper sulphate	49
Control plus manganese sulphate, copper sulphate and zinc sulphate ..	44
Control plus mixture M	46
Control plus mixture Q	50

Difference necessary for significance ($P = 0.05$) = $\pm$ 3 mins.

Treatment.	mins.
Series 3.	
Control—N + P + K	47
Superphosphate only—2 cwt. per acre ..	52
Superphosphate plus borax	51
Superphosphate plus manganese sulphate	50
Superphosphate plus zinc sulphate ..	42
Superphosphate plus copper sulphate ..	51

Difference necessary for significance ($P = 0.05$) = $\pm$ 3 mins.

Mixture M contains manganese, copper, zinc, magnesium and ferrous sulphates and borax. Mixture Q contains sodium tungstate, cobalt chloride, antimony chloride, potassium iodide and nickel chloride each at the rate of 5 lbs. per acre

Fertilisers were applied at the following rates—Control mixture: Sulphate of ammonia, 1 cwt per acre; Superphosphate, 2 cwt. per acre; Sulphate of potash, 0.5 cwt. per acre "Minor" elements: Manganese sulphate, copper sulphate, zinc sulphate, ferrous sulphate and magnesium sulphate—each 20 lbs. per acre Borax 10 lbs per acre

From series 1, none of the "minor" elements has improved the baking quality of the wheat and only the application of zinc sulphate has significantly decreased the baking quality.

From series 2, none of the "minor" elements has improved the baking quality of the wheat and the application of zinc sulphate in combination with other minor elements has decreased the baking quality.

From series 3, the use of nitrogenous and potassic fertilisers in addition to superphosphate has significantly decreased the baking quality of the grain. None of the "minor" elements has improved the baking quality but the use of zinc sulphate has significantly decreased the baking quality.

(b) Since the samples of grain available were too small for each to be milled and farinographed the six samples from each treatment were bulked in two lots of three samples each and each bulk lot milled and farinographed. This resulted in duplicate determinations on each treatment and the averages of these duplicates are shown in Table 2.

TABLE 2.

The baking quality, as judged by the Farinograph, of Nabawa wheat fertilised with "minor" elements.

Treatment.	Farinogram. W.A. %	S.F.	D.W.	D.D.T.
Series 1.				
Control—N + P + K	60.8	5.6	80	1.6
Control plus copper sulphate ..	59.8	5.8	70	1.8
Control plus manganese sulphate ..	59.6	5.8	80	1.5
Control plus borax	59.8	6.1	70	1.6
Control plus zinc sulphate	59.6	5.1	110	1.6
Control plus manganese sulphate ..	59.8	5.8	80	1.6

TABLE 2—*continued.*

Treatment.	Farinogram. W.A. %	S.F.	D.W.	D.D.T.
Series 2.				
Control—N + P + K	59.5	6.6	70	1.8
Control plus ferrous sulphate ..	59.7	7.2	50	1.6
Control plus manganese sulphate and copper sulphate	59.6	6.6	70	1.5
Control plus manganese sulphate, copper sulphate and zinc sulphate ..	60.1	6.3	75	1.5
Control plus mixture M	59.8	6.8	70	1.6
Control plus mixture Q	59.8	6.5	70	1.6
Series 3.				
Control—N + P + K	59.2	6.2	70	1.8
Superphosphate only—2 cwt. per acre	60.2	6.8	60	1.6
Superphosphate plus borax	59.9	6.6	65	1.5
Superphosphate plus manganese sulphate	59.7	6.4	70	1.6
Superphosphate plus zinc sulphate ..	60.7	5.6	90	1.5
Superphosphate plus copper sulphate	59.7	6.8	60	1.6

W.A. is water absorption on 13.5% moisture basis. S.F. is strength figure: the time in minutes from the commencement of mixing until the top of the farinogram falls below the maximum consistency of 500 units. D.W. is dough weakening: the number of consistency units by which the median line of the farinogram has fallen below the maximum consistency of 500 units after 10 minutes mixing. D.D.T. is dough development time: the time in minutes from the commencement of mixing till the farinogram attains maximum width. Rates of application of fertilisers are as noted under Table 1.

The farinogram results cannot be treated statistically so that no accurate estimation of significance can be given but general experience with the farinograph indicates that in Series 1, no "minor" element has affected the water absorption or the dough development time of the flour. The only effect of "minor" elements on strength figure is that the application of zinc sulphate has decreased the strength figure with a consequent increase in dough weakening.

In series 2, no "minor" element or combination of "minor" elements has affected the water absorption or dough development time of the flour. The addition of ferrous sulphate has increased the strength figure with a consequent decrease in the dough weakening.

In series 3, no treatment has materially affected either the water absorption or the dough development time of the flour. The addition of nitrogenous and potassic fertilisers has decreased the strength figure and hence increased the dough weakening as compared with superphosphate alone. The addition of zinc sulphate has considerably decreased the strength figure and increased the dough weakening. These results confirm the findings of the "wholemeal fermentation time" test.

In addition to the effect on the analytical results for baking quality the use of zinc sulphate resulted in a substantial lowering of the commercial qualities of the grain as it caused considerable to very severe shrivelling of the grain and induced a dirty, greyish colour on most of the injured grain.

(4) *Wagin.*

To make qualitative observations on the effects of some "minor" elements on some representative types of light land an exploratory experiment with wheat was carried out using plots of 0.43 acres each in area and 14.3 chains long. Each treatment was in duplicate with the control plot regularly interspersed so that there were eight control plots.

Nabawa wheat was sown on clean fallow in good condition and all plots, except those receiving superphosphate only, received a basal fertiliser dressing at the rate of 1 cwt. of superphosphate and 0.5 cwt. of sulphate of potash per acre. The "minor" elements were mixed with the basal fertiliser and applied by means of a combine drill in the usual way, the drill being frequently checked for rates of sowing.

Harvester samples from each plot were examined and the average results are shown in Table 3.

TABLE 3.

The baking quality, as judged by the Farinograph and "wholemeal fermentation time," of Nabawa wheat fertilised with "minor" elements.

Treatment.	Farinogram.				Time.
	W.A. %.	S.F.	D.W.	D.D.T.	(mins.)
Superphosphate	62.2	6.4	70	1.9	47
Control—Superphosphate plus sulphate of potash	62.6	5.8	75	1.7	46
Control plus manganese	62.8	6.2	65	1.6	44
Control plus iron	62.4	6.4	60	1.6	44
Control plus copper	62.4	5.6	80	1.6	48
Control plus zinc	62.6	6.0	70	1.8	42
Control plus cobalt	62.4	6.5	70	1.8	46
Control plus boron	62.5	5.6	90	1.5	51
Control plus copper, manganese, and zinc	62.6	6.1	70	1.6	46

W.A is water absorption S.F is strength figure D.W is dough weakening. D.D.T. is dough development tim Time is "wholemeal fermentation time."
Rates of application of fertilisers —Superphosphate, 1 cwt. per acre, Sulphate of potash, 0.5 cwt. per acre. Manganese sulphate, ferrous sulphate, copper sulphate, 20 lbs per acre; Zinc sulphate, borax, 10 lbs. per acre. Cobalt chloride, 1 lb per acre

Though no statistical estimate of significance can be given for these results it appears that the addition of zinc sulphate to the basal fertiliser has decreased the "wholemeal fermentation time" and the addition of borax has increased it. No treatment has materially affected the water absorption or dough development time of the flour. The omission of sulphate of potash from the basal fertiliser has increased the strength figure, as has the addition of ferrous sulphate and cobalt chloride. No "minor" element treatment has materially decreased the strength figure.

The indications from the two tests used for baking quality are therefore not consistent and further information is required before definite conclusions can be drawn.

(5) *Summary and conclusions.*

Samples of Nabawa wheat from two experiments on the use of "minor" elements as fertilisers for wheat on light land have been examined for baking quality.

The addition of sulphate of potash, with or without the addition of sulphate of ammonia, decreased the "strength" of the flour obtained.

None of the "minor" elements tested affected materially the water absorption or dough development time of the flour.

As with other agronomic characters, the effect of "minor" elements on "strength" of flour varies with locality, a decrease in "strength" being caused by zinc sulphate fertiliser at the Wongan Hills Research Station but not at Wagin.

It appears that the use of "minor" elements as fertilisers for wheat grown on light land will not effect a substantial increase in baking quality. There is some indication that the application of ferrous sulphate may improve the baking quality slightly.

"Minor" elements, particularly zinc salts, may decrease the baking quality and should be used with great care.

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ACKNOWLEDGMENTS.

The author wishes to acknowledge the assistance of colleagues for provision of the samples and of the Forests Department in undertaking the statistical treatment of certain of the results.

Sheep Dipping—An Essential for Healthy Flocks.

HUGH MCCALLUM, Sheep and Wool Inspector.

Most flocks will now have been dipped, but it is considered imperative to issue a warning to those who have neglected to carry out this function, so essential to success in sheep husbandry.

Many clips inspected on the Show floors bear mute testimony of the lack of proper care and attention given to this phase of the wool industry, as the wools show discoloration, through using incorrectly mixed solutions, dipping at the wrong time of the year, etc., and poor quality, stain and damage from insect infestation.

Tick and lice are blood sucking parasites and infest all parts of the body of the animals. Their presence may be suspected when sheep are seen to rub themselves against logs, fence posts, etc.; a few sheep should then be caught and carefully examined in a strong lights as the parasites lie deep in the wool close to the skin.

The intense irritation caused by these sucking parasites upsets the sheep, making it restless and unable to settle to feed properly, with consequent loss of condition, while young sheep infested lose stamina and cannot develop. Their effect, however, is most apparent on the wool, which becomes roughened and dragged and considerably lessened in value. In the case of badly infested animals sometimes the skin is rubbed completely bare and often raw, and is thus an invitation to blow-fly attack.

Control of tick and lice is dependent upon dipping, which must be done at the right time, with the correct concentration of a suitable chemical (mixed strictly in accordance with the manufacturer's instruction) and so that the animal is completely immersed in the solution. This last proviso is very important, for if one animal escapes, or even dodges having its head submerged, it proves a harbour for

a few parasites which will quickly reproduce their species and re-infest the flock, thus rendering all the expense and time expended lost effort as far as maintaining a clean flock is concerned.

The ideal time to dip is from four to six weeks after shearing is completed, using any of the standard commercial preparations.

With the exercise of reasonable care in the observation of the following precautions, dipping can be made a safe and profitable practice.

(1) Do not dip in extremely hot or cold weather. Wait for a warm, fairly windless day.
(2) Do not dip hot, thirsty, or overfed sheep. Drive them to the yards the evening before and allow them time to rest and cool off.
(3) Commence dipping early and cease at least two hours before sundown to enable animals to dry off before nightfall.
(4) Completely immerse each animal at least once.
(5) Permit dipped sheep to drain in a pen before being released on to pasture, so that no poisonous material will be broadcast through the feed.
(6) Keep sucking lambs separate from mothers until the ewes have drained and dried out.

No. 4 can be accomplished by having one person stationed along the swim section of the dip armed with a pole to the end of which has been affixed a disc of smooth wood about 6in. in diameter, which is pressed just behind the shoulders of each sheep as it swims through, causing the animal to completely submerge but quickly come to the surface again.

In the case of No. 5, the fluid from the draining pen should run back into the dip and not be permitted to spread out over surrounding land, though as far as possible droppings from the animals should be swept into a shallow grated sump to prevent their contaminating the dipping solution.

After the ewes have been completely drained of solution the lambs should be returned to them in a small yard and care taken to see that each animal is "mothered" before nightfall.

After each batch of sheep have been dipped, the surface of the fluid can be skimmed with a fine wire sieve to remove scum of grease, burrs, etc., that forms on the top, and the bath well agitated by vigorously plunging the "prod" up and down to keep the chemical in solution.

The sheep farmer must come to realise the fact that unless he makes a determined effort to eradicate or control these parasites he cannot expect to farm at a profit. Sheep from infested flocks produce weakly lambs and those characteristically diseased looking clips which open up so unattractively in comparison with the bright clean fleeces of healthy animals.

In districts where small flocks are pastured the expense of providing a dip and handling yards on each holding is rather excessive but this difficulty can easily be overcome by the construction of a community dip at a convenient situation, the cost and maintenance of which can be shared evenly by all users.

By the high grade of some of her clips Western Australia has proved that she can produce wool comparable with the best from all other States of the Commonwealth, but this grade can only be maintained by care and attention to the flocks and it therefore behoves the sheep owner, not only to make his own livelihood a profitable on, but for the future of the State to practise only the best methods of sheep husbandry, and among these "dipping" is a principal.

Cereal Varieties Available for Distribution.

I. Thomas, Superintendent Wheat Farming.

The value of the use of the highest quality stock, with special regard to its productivity and disease resistance, has long been realised amongst stock breeders. With plants, these two same factors again play a most important part, a fact which is now realised by successful and progressive farmers.

For a cereal variety to be recommended and widely distributed amongst farmers it must be high yielding, disease and drought resistant, have satisfactory straw strength and threshing qualities and, with wheat, be of satisfactory milling and baking quality. In addition, the cereal variety must be suitable for the district in which it is to be grown, having particular regard to the prevailing climatic conditions and the purpose for which the crop is to be grown.

It is realised that quite a considerable number of farmers are not aware of the advantages to be gained from the use of pedigree seed, although they may regularly make use of pedigree stock. Many years ago even the grading of grain to be used for seed was considered so much waste of time (it was all wheat so why worry—sow it a bit heavy in case of accidents)—but the grading of ordinary commercial wheat for seed is not sufficient to ensure the use of the highest quality seed.

Experimental results have shown that though the use of graded seed has a definite advantage over ungraded seed, grading does not, however, prevent admixture of other varieties or maintain the particular variety at its highest yielding capacity.

It is not sufficient to produce new varieties by cross-breeding and selection over a number of years and then release them for general cultivation, but the different varieties must be maintained during subsequent years at the highest level of prolificacy. The maintaining of this high level can only be achieved by continual selection which is not a practical proposition on the ordinary farm.

One of the principal functions of the Agricultural Research Stations located in the Wheat Belt is and has been for many years, the production of selected pedigree seed of the standard varieties of wheat, oats and barley. In view of the highly specialised work, and facilities required, for the production, and maintenance of the purity, of this seed, the cost of this work is relatively high when compared with the commercial production of grain.

At each of two Research Stations, Merredin and Wongan Hills, a specialist is located, who, in addition to the breeding of new varieties, is required to carry out the initial stages and supervise the work involved in the raising of pedigree seed without which the high standard of quality and purity of the pedigree seed made available to settlers would not be possible.

At those Stations what are known as "Pure Line Breeding Rows" are conducted: these include rows of all the varieties which are distributed to settlers from these and the other Research Stations. Each year the most prolific plants having the typical characteristics of the varieties concerned are selected from the individual rows; the seed from these selections is then reserved for planting similar selection rows for the following year. The balance of the seed is harvested for planting in a larger area "The Accumulation Plot," from which the seed is obtained for the "Stud Plots" at the various Research Stations; these providing in their turn the seed for the "Bulk Plots" from which the farmer obtains his supplies of pedigree seed

As would be expected the work involved with the "Pure Line Breeding Rows" is most specialised. Each row is planted, tended and harvested by hand, each individual variety is separated one from the other by a buffer row of a different cereal and the selected individual heads are covered by transparent waterproof paper bags immediately prior to the flowering stage. Further, the individual varieties planted in the "Accumulation," "Stud" and "Bulk" plots are also kept separate by buffer plots of a different cereal. These plots are kept under constant supervision for any signs of variation and all wheat varieties planted are each year tested for their resistance to flag smut. In the case of new wheat varieties these are tested in the Cereal Research laboratory to determine their milling and baking qualities, as no new wheat variety is released for general cultivation unless it is at least equal in these qualities to the variety which it is intended to replace.

It will thus be seen that the seed obtained by the farmer is the direct result of the selection of a single plant which developed from a single seed. Only in this way is it possible to maintain the purity and high yielding capacity of the variety.

When making available supplies of pedigree seed, produced at the Agricultural Research Stations, for distribution to farmers, it is not possible for farmers to obtain all of their seed requirements in this way from the Department. It is recommended, however, that each year they should obtain a few bags of pedigree seed of the variety or varieties they normally grow, sow this seed in a "Stud Plot" or plots and then use the grain obtained for their seed requirements the following year. In this way, farmers are enabled to maintain the prolificacy of the different varieties grown by them at a relatively small cost.

Furthermore, the aim of the Department is to supply as many farmers as possible with pedigree seed and thus, owing to the fact that the demand for some of the varieties is greater than the supply, it is often necessary to limit the amount of each variety supplied to any one applicant in order that he may be able to obtain at least some pedigree seed.

It is anticipated that this year the following varieties will be available for distribution—

WHEAT.

Baroota Wonder.—A late maturing variety, resistant to flagsmut, but is liable to rust. This variety is recommended for hay in the better rainfall districts.

Bencubbin.—A midseason maturing variety, resistant to flagsmut, but is very liable to rust and is not recommended for those districts where rust is feared.

Bungulla.—A selection from Bencubbin, early maturing, drought resistant variety, resistant to flagsmut, susceptible to rust, but tends to be rust escaping on account of its early maturity.

Carrabin.—An early maturing variety of high quality grain; resistant to flagsmut and rust escaping.

Comeback.—An early-midseason maturing variety of premium milling quality. It is resistant to flagsmut and rust escaping.

Ford.—A midseason maturing variety, resistant to flagsmut and rust.

Geeralying.—A very early maturing variety, resistant to flagsmut and rust escaping. It is liable to shed.

Gluyas Early.—An early maturing variety; resistant to rust but liable to flagsmut.

Merredin.—An early maturing variety, susceptible to flagsmut, but rust escaping.

Nabawa.—A midseason maturing variety, resistant to flagsmut and rust. Recommended for those areas where rust is feared.

Noongaar.—A very early maturing variety which is drought resistant, being most suitable for areas having a short growing period and for very late planting in those districts having a better rainfall; resistant to flagsmut and rust escaping.

S.H.J.—An early maturing variety producing a grain of high milling quality. It is resistant to flagsmut and rust.

Sutton.—A late maturing variety, resistant to flagsmut and moderately resistant to rust. This variety is not recommended for areas of low rainfall.

Totadgin.—An early maturing variety; resistant to flagsmut.

OATS.

Algerian.—Late maturing variety. Owing to slow early growth it is not recommended for early green feed.

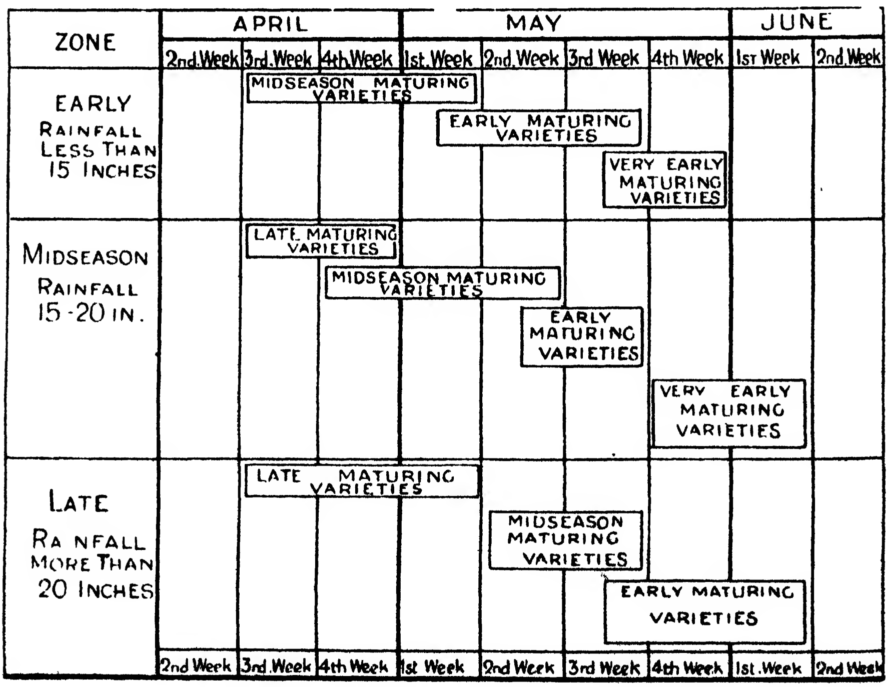
Burt's Early.—An early maturing variety which is especially suitable for hay, silage and early green feed.

Guyra.—A midseason maturing variety mostly favoured for its grain which is large and plump.

Mulga.—An early maturing variety suitable for hay, grain, silage and early green feed; superior to Burt's Early for grain.

Wongan.—A very early maturing variety which was produced at the Wongan Hills Research Station from a cross between Mulga and Burt's Early. It has short, strong straw and is suitable for early green feed and grain in the drier areas or for late planting in the wetter districts.

SEEDING CALENDAR WITH RECOMMENDED VARIETIES FOR THE WESTERN AUSTRALIAN WHEAT BELT.



RECOMMENDED VARIETIES.

Late Maturing	Midseason Maturing.	Early Maturing.	Very Early Maturing.
Wheat— Sutton, Yandilla King, Baroota Wonder (for Hay)	Bencubbin, Ford, Nabawa	Gluyas Early, Merredin, Totadgin, Bungulla Premium Varieties— Carrabin, Comeback, Pusa IV., S.H.J.	Geeralying, Noongaar.
Oats— Algerian	Guyra	Burt's Early, Mulga	Wongan.

When planting for hay, sow 7-10 days earlier than for grain.

BARLEY.

Atlas.—A six-rowed barley which has been introduced from California, it is also known in this State as Californian Six-Row Barley. In England it is used for malting purposes, but it is not employed for this purpose by local brewers whose technique is based on the use of two-row barleys such as Pryor. It is grown mainly for green feed and is quite equal in this respect to Cape, Bald Skinless or Black Barley, while for grain its yield is superior to Cape.

Applications for pedigree seed should be made *direct* to the Department of Agriculture, Perth.

The seed may be obtained either on a cash basis or under the Exchange System, which has operated for the past few years, when the farmer has been able to exchange his own f.a.q. wheat for pedigree seed on the following basis:—

4½ bushels f.a.q. wheat for 3 bushels pedigree seed wheat or barley.
3 bushels f.a.q. wheat for 3 bushels pedigree seed oats.

Both of these transactions are inclusive of rail freight on the seed to the settler's siding.

Applicants are advised to make early application for their requirements, setting out clearly their name and postal address, together with the siding to which the seed is to be railed.

Fertilisers.

H. G. CARISS,
Assistant Inspector of Fertilisers.

The new fertiliser year commenced on the 1st November, 1939, and in accordance with the Fertiliser Act, 1928, the list of fertilisers registered for the current year are appended hereunder in tabular form.

Under the provisions of the Fertiliser Act, 1928, and the regulations thereunder, it is provided that all fertilisers sold in this State shall be registered, sold under a registered brand and in a package on which is conspicuously marked a copy of the registered brand and the name of the fertiliser. The act of registering a fertiliser is a form of guarantee to the consumer that he is obtaining what

he is paying for. Also, in order to ensure that the material demanded and paid for is supplied it is encumbent upon the seller, provided that the quantity sold is one hundredweight or more, to issue an invoice, on the prescribed form, with each sale, and include on the invoice the minimum percentages of the fertilising ingredients and, when applicable, other particulars such as fineness, etc.

Furthermore, inspectors are appointed under the Act, and, during the year, periodical inspection of the places where fertilisers are kept for sale or sold are made, and samples taken and submitted to the Government Analyst for analysis.

Manufacturers, as a rule, aim at keeping the analysis of their different fertilisers close to the guaranteed figures as an indication of care in manufacturing and dependability of their product.

From time to time brands of fertilisers make their appearance on the market, especially so-called special garden manures, which are supposed to be a panacea for all plant evils, and on analysis are found to be either worthless or far more costly than their ingredients would justify. Such fertilisers should be treated with caution and information sought from the Department of Agriculture as to their registered analyses and comparable values.

As a guide to agriculturists in purchasing their manures the unit values for the different forms of the main fertilising ingredients, nitrogen, phosphoric acid and potash, have been calculated from the quoted prices per ton.

The system of units and unit values enables an approximation of the comparative monetary values of similar fertilisers to be made. At first sight it may appear that a comparison of the quoted costs per ton would be satisfactory, but as the registered minimum percentages of the fertilising ingredients are not always similar this is not so.

The amount of a fertilising ingredient in a fertiliser, *e.g.*, nitrogen in sulphate of ammonia, is measured in terms of units, one unit being one per cent. by weight per ton. Therefore, the unit value for nitrogen in sulphate of ammonia containing 20 per cent. nitrogen and costing £12 per ton would be £12/20 or 12s.

In a similar way the unit values for the other fertilising ingredients in their various forms may be obtained. Though these unit values approximate fairly closely to the fertilising value, it must be clearly understood that they are not the definite value but are governed by the current market rates. Further, the total of the individual unit values in each fertiliser is not necessarily equal to the quoted price as the calculated values are averages of all the fertilisers of that class offered for sale. Also with mixed mineral fertilisers, *viz.*, potato manures, etc., the cost of mixing and extra handling must be added to the cost of the ingredients, but the unit values still serve as a definite guide to the relative usefulness of the different mixtures for any specific purpose.

To illustrate this comparison by unit values a simple example will serve, say—

	Minimum percentages of Nitrogen.	Minimum percentages of Phosphoric Acid.	Quoted price per ton.
X. brand blood and bone ..	6.5	10	£12
Y. brand blood and bone ..	5.5	13	£12

From the appended table of unit values for the current fertiliser year, that for nitrogen in blood and bone is 22s. 4d. and for phosphoric acid 5s. 7d. therefore, using these figures we now obtain the computed value for each fertiliser—

X Brand Blood and Bone.

	s.	d.
6.5 units of nitrogen at 22s. 4d. per unit	145	2
10 units of phosphoric acid at 5s. 7d. per unit	55	10
Total value	201	0

Y Brand Blood and Bone.

	s.	d.
5.5 units of nitrogen at 22s. 4d. per unit	122	10
13 units of phosphoric acid at 5s. 7d. per unit	72	7
Total value	195	5

It will be seen, therefore, that as the units contained in X brand are worth more than those of Y brand the former would be the more economical fertiliser to purchase when they are both priced at £12 per ton.

Unit values should be used only in comparing fertilisers of similar types, as manufacturing costs vary greatly with the class of fertiliser as also do the length of time and extent to which the fertilising ingredients become available. For instance, the nitrogen as nitrate or ammonia is readily available and unit values should not be used in comparing either of them with that as blood and bone or bone dust which are less readily available.

The main variations from last year's values are a decrease in blood and bone and bone dust for organic nitrogen and phosphoric acid of 1s. 8d and 5d. per unit respectively and an increase of 9d. per unit for ammoniacal nitrogen. The values for the other fertilisers have remained constant.

It must be noted that due to the present world situation these unit values are subject to alteration, but will still serve as a guide for comparison of similar types of fertilisers.

In the table hereunder the unit values for the current year are shown in comparison with those for the previous three seasons.

UNIT VALUES.

----	1936-37.		1937-38.		1938-39.		1939-40.	
Nitrogen (N) as—	s.	d.	s.	d.	s.	d.	s.	d.
Dried Blood	...		...		..		26	0
Blood and Bone, Bonedust and Bone and Flesh ...	21	8	23	0	24	0	22	4
Nitrate	18	2	18	1	18	1	18	1
Ammonia	11	8	11	3	11	2	11	11
Phosphoric Acid (P_2O_5) as—								
Water soluble as superphosphate	3	4	3	3	3	3	3	3
Citrate soluble as superphosphate	3	4	3	3	3	3	3	3
Blood and Bone, Bonedust and other animal fertilisers	5	6	5	9	6	0	5	7
Basic Phosphate	4	11	4	11	4	11	4	11
Acid soluble in superphosphate and rock phosphate	2	2	2	2	2	2	2	2
Potash (K_2O) as—								
Sulphate	6	4	6	5	6	5	6	5
Muriate	5	6	5	7	5	7	5	7

FERTILISERS.

The following fertilisers have been registered at the Department of Agriculture under the Fertilisers Act, 1928, for the year commencing 1st November, 1939:—

Name of Fertiliser.	Reg. No.	Brand.	By whom Registered.	Nitrogen (N) as: Nitrate.	Nitrogen (N) as: Ammonia.	Nitrogen (N) as: Blood and Bone	Nitrogen (N) as: Bonedust	Phosphoric Acid (P_2O_5) as: Water sol.	Phosphoric Acid (P_2O_5) as: Citrate sol.	Phosphoric Acid (P_2O_5) as: Acid sol.	Phosphoric Acid (P_2O_5) as: Total.	Potash (K_2O) as: Sulphate.	Potash (K_2O) as: Muriate.	Cash Price per ton on rails at Works † or Perth.‡
A.—MINERAL.														
1. NITROGENOUS:				%	%	%	%	%	%	%	%	%	%	£ s. d.
(a) *Nitrogen as Nitrate*														
Nitrate of Soda	33	Sickle	Cuming Smith & Mt. Lyell F.F., Ltd.	15·5										†14 0 0
Do.	61	ML (in diamond)	do. do.	15·5										†14 0 0
Do.	89	CSML	do. do.	15·5										†14 0 0
Do.	117	Cresco	Cresco Fertilisers (W.A.). Ltd.	15·5										†14 0 0
(b) *Nitrogen as Ammonia:*														
Sulphate of Ammonia	9	ICIANZ	Nitrogen Fertilisers, Ltd.		20·6									†12 5 0
Do.	32	Sickle	Cuming Smith & Mt Lyell F.F., Ltd.		20·5									†12 5 0
Do.	60	ML (in diamond)	do. do.		20·5									†12 5 0
Do.	88	CSML	do. do.		20·5									†12 5 0
Do.	114	Cresco	Cresco Fertilisers (W.A.), Ltd.		20·5									†12 10 0
2. PHOSPHATIC—														
(a) *Rock Phosphate:*														
Pacific Islands Phosphate	31	Sickle	Cuming Smith & Mt. Lyell F.F., Ltd.							36·65	36·65			† 4 0 0
Do.	59	ML (in diamond)	do. do.							36·65	36·65			† 4 0 0
Do.	92	CSML	do. do.							36·65	36·65			† 4 0 0
Phosphate Powder	113	Cresco	Cresco Fertilisers (W.A.), Ltd.							36·65	36·65			† 4 0 0
(b) *Superphosphate:*														
Florida Superphosphate, 22 per cent.	10	Sickle	Cuming Smith & Mt Lyell F.F., Ltd.					20·5	0·5	1·0	22·0			† 3 12 6
Florida Superphosphate, 23 per cent.	11	do.	do. do.					21·25	0·5	1·25	23·0			† 3 12 6
22 per cent. Superphosphate	38	ML (in diamond)	do. do.					20·5	0·5	1·0	22·0			† 3 12 6
High Grade Superphosphate, 23 per cent.	39	do. do.	do. do.					21·25	0·5	1·25	23·0			† 3 12 6
22 per cent. Superphosphate	66	CSML	do. do.					20·5	0·5	1·00	22·0			† 3 12 6
High Grade Superphosphate, 23 per cent.	67	do.	do. do.					21·25	0·5	1·25	23·0			† 3 12 6
"23" Superphosphate	97	Cresco	Cresco Fertilisers (W.A.), Ltd.					21·25	0·5	1·25	23·0			† 3 12 6

(c) *Rock Phosphate and Superphosphate:*														
Phosphate Mixture 50/50	30	Sickle	Cuming Smith & Mt. Lyell F.F., Ltd.					10·0	0·5	18·5	29·0			† 4 1 6
Do.	58	ML (in diamond)	do. do.					10·0	0·5	18·5	29·0			† 4 1 6
Do.	87	CSML	do. do.					10·0	0·5	18·5	29·0			† 4 1 6
50/50 Phosphate	98	Cresco	Cresco Fertilisers (W.A.), Ltd.					10·0	0·5	18·5	29·0			† 4 1 6
(d) *Basic Phosphate:*														
Basic Phosphate	29	Sickle	Cuming Smith & Mt. Lyell F.F., Ltd							17·0	17·0			† 4 4 0
Do.	57	ML (in diamond)	do. do.							17·0	17·0			† 4 4 0
Do.	78	CSML	do. do.							17·0	17·0			† 4 4 0
3. POTASSIC—														
(a) *Potash as Sulphate:*														
Sulphate of Potash	34	Sickle	do. do.									48·6		†15 10 0
Do.	62	ML (in diamond)	do. do.									48·6		†15 10 0
Do.	90	CSML	do. do.									48·6		†15 10 0
Do.	115	Cresco	Cresco Fertilisers (W.A.), Ltd.									48·6		†15 10 0
Do.	121	Palestine	George Wills & Co., Ltd.									48·6		§
Do.	125	Sun	West Farmers, Ltd									48·6		
(b) *Potash as Muriate*														
Muriate of Potash	35	Sickle	Cuming Smith & Mt. Lyell F.F., Ltd.										50·0	†14 0 0
Do.	63	ML (in diamond)	do. do.										50·0	†14 0 0
Do.	91	CSML	do. do.										50·0	†14 0 0
Do.	116	Cresco	Cresco Fertilisers (W.A.), Ltd.										50·5	†14 0 0
Do.	122	Palestine	George Wills & Co., Ltd.										50·0	
Do.	128	Sun	Westralian Farmers, Ltd.										50·0	
Kainit	124	do.	do. do.										14·0	
Potash Manure Salts	127	do.	do. do.										30·0	
4. NITROGEN AND PHOSPHORIC ACID—														
Super and Ammonia, No. 1	22	Sickle	Cuming Smith & Mt. Lyell F.F., Ltd		2·94			17·57	0·43	0·85	18·85			† 5 10 6
Do. No. 2	23	do.	do. do.		5·15			15·37	0·37	0·76	16·50			† 6 10 0
Do. No. 3	24	do.	do. do.		6·0			14·25	0·4	1·1	15·75			† 6 15 0
Do. No. 4	25	do.	do. do.		6·87			13·66	0·34	0·66	14·66			† 7 4 0
Do. No. 5	26	do.	do. do.		10·30			10·25	0·25	0·50	11·00			† 8 14 0
Do. No. 1	50	ML (in diamond)	do. do.		2·94			17·57	0·43	0·85	18·85			† 5 10 6
Do. No. 2	51	do. do.	do. do.		5·15			15·37	0·37	0·76	16·50			† 6 10 0
Do. No. 3	52	do. do.	do. do.		6·0			14·25	0·4	1·1	15·75			† 6 15 0
Do. No. 4	53	do. do.	do. do.		6·87			13·66	0·34	0·66	14·66			† 7 4 0
Do. No. 5	54	do. do.	do. do.		10·3			10·25	0·25	0·50	11·0			† 8 14 0
Do. No. 1	82	CSML	do. do.		2·94			17·57	0·43	0·85	18·85			† 5 10 6

§ Prices on application.

FERTILISERS—*continued.*

Name of Fertiliser.	Reg. No.	Brand.	By whom Registered	Nitrogen (N) as Nitrate.	Ammonia.	Blood and Bone	Bone-dust.	Phosphoric Acid (P_2O_5) as Water sol.	Citrate sol.	Acid sol.	Total.	Potash (K_2O) as Sulphate.	Muriate.	Cash Price per ton on rails at Works † or Perth. ‡
				%	%	%	%	%	%	%	%	%	%	£ s. d.
4. NITROGEN AND PHOSPHORIC ACID—*continued.*														
Super and Ammonia, No. 2	83	CSML ...	Cuming Smith & Mt. Lyell F.F. Ltd.		5·15			15·37	0·37	0·76	16·50			† 6 10 0
Do. No. 3	84	do.	do. do.		6·0			14·25	0·4	1·1	15·75			† 6 15 0
Do. No. 4	85	do.	do. do.		6·87			13·66	0·34	0·66	14·66			† 7 4 0
Do. No. 5	86	do.	do. do.		10·3			10·25	0·25	0·5	11·0			† 8 14 0
Do. 6 : 1	99	Cresco	Cresco Fertilisers (W.A.), Ltd.		2·94			17·57	0·43	0·85	18·85			† 5 10 6
Do. 3 : 1	100	do.	do. do.		5·15			15·37	0·37	0·76	16·30			† 6 10 0
Do. 2 : 1	101	do.	do. do.		6·87			13·66	0·34	0·66	14·66			† 7 4 0
Do. 1 : 1	102	do.	do. do.		10·3			10·25	0·25	0·5	11·0			† 8 14 0
Potato Manure C	13	Sickle	Cuming Smith & Mt. Lyell F.F., Ltd.		3·5			16·75	0·40	1·10	18·25			† 5 16 0
Do. F	15	do.	do. do.		6·0			14·25	0·40	1·10	15·75			† 6 15 0
Do. No. 2	40	ML (in diamond)	do. do.		3·5			16·75	0·40	1·1	18·25			† 5 16 0
Do. No. 6	44	do. do.	do. do.		6·0			14·25	0·40	1·1	15·75			† 6 15 0
Do. C	69	CSML	do. do.		3·5			16·75	0·4	1·1	18·25			† 5 16 0
Do. F	71	do.	do. do.		6·0			14·25	0·4	1·1	15·75			† 6 15 0
Phosphate of Ammonia	134	Floraphos	J. A. Newman & Co.		15·6			31·20			31·20			†35 0 0
5. NITROGEN, PHOSPHORIC ACID AND POTASH—														
Potato Manure B	12	Sickle	Cuming Smith & Mt. Lyell F.F. Ltd.		3·75			14·5	0·35	0·75	15·6	4·5		† 7 2 0
Do. E	14	do.	do. do.		3·5			14·0	0·3	0·7	15·0	8·0	..	† 7 19 0
Do. G	16	do.	do. do.		3·5			10·5	0·2	0·6	11·3	16·0	..	†10 0 0
Do. H	17	do.	do. do.		4·0			12·7	0·3	0·7	13·7	9·0		† 8 8 0
Do. No. 5	18	do.	do. do.		7·5			7·0	0·2	0·4	7·6	13·25		†11 1 0
Orchard Manure	19	do.	do. do.		2·0			15·75	0·4	1·1	17·25		5·0	† 6 6 0
Special Mixture K	20	do.	do. do.		8·34			8·4	0·2	0·4	9·0	..	10·04	†10 2 6
Do. KP	21	do.	do. do.		6·34			10·5	0·2	0·8	11·5	10·04		† 9 13 0
Tobacco Fertiliser	28	do.	do. do.	3·3				14·0	0·5	1·0	15·5	5·7		† 7 10 0
Potato Manure No. 3	41	ML (in diamond)	do. do.		3·75			14·5	0·35	0·75	15·6	4·5		† 7 2 0
Do. No. 4	42	do. do.	do. do.		3·5			14·0	0·3	0·7	15·0	8·0	..	† 7 19 0
Do. No. 5	43	do. do.	do. do.		7·5			7·0	0·2	0·4	7·6	13·25		†11 1 0
Do. No. 7	45	do. do.	do. do.		3·5			10·5	0·2	0·6	11·3	16·0		†10 0 0
Do. No. 8	46	do. do.	do. do.		4·0			12·7	0·3	0·7	13·7	9·0		† 8 8 0
Orchard Manure	47	do. do.	do. do.		2·0			15·75	0·4	1·1	17·25		5·0	† 6 6 0
Special Mixture K	48	do. do.	do. do.		8·34			8·40	0·2	0·4	9·0		10·04	†10 2 6
Do. KP	49	do. do.	do. do.		6·34			10·5	0·2	0·8	11·5	10·04		† 9 13 0
Tobacco Fertiliser	56	do. do.	do. do.	3·3				14·0	0·5	1·0	15·5	5·7		† 7 10 0
Potato Manure B	68	CSML	do. do.		3·75			14·5	0·35	0·75	15·6	4·5		† 7 2 0
Do. E	70	do.	do. do.		3·5			14·0	0·3	0·7	15·0	8·0	..	† 7 19 0

Do. G	72	do.	do do		3.5		10.5	0.2	0.6	11.3	16.0		†10 0 0
Do. H	73	do.	do do.		4.0		12.7	0.3	0.7	13.7	9.0		† 8 8 0
Do. No 5	74	do.	do do		7.5		7.0	0.2	0.4	7.6	13.25		†11 1 0
Orchard Manure	79	do	do do		2.0		15.75	0.4	1.1	17.25		5.0	† 6 6 0
Special Mixture K	80	do.	do do		8.34		8.4	0.2	0.4	9.0		10.04	†10 2 6
Do. KP	81	do.	do do		6.34		10.5	0.2	0.8	11.5	10.04		† 9 13 0
Tobacco Fertiliser	76	do	do do.	3.3			14.0	0.5	1.0	15.5	5.7		† 7 10 0
Do. No. 2	77	do	do. do	3.7			13.2	0.3	0.7	14.2	7.0		† 7 14 0
Potato Special	104	Cresco	Cresco Fertiliser (W.A.), Ltd.		4.0		12.7	0.3	0.7	13.7	9.0		† 8 8 0
Potato Manure	105	do.	do. do.		1.5		7.1	1.4	13.5	22.0	7.5		† 6 15 0
Vine Manure	108	do.	do. do.		1.5		7.10	1.40	13.5	22.0	7.5		† 6 15 0
Orchard Manure	106	do.	do. do		1.5		7.10	1.40	13.5	22.0	7.5		† 6 15 0
Mixed Manure	107	do.	do. do		1.5		7.10	1.40	13.5	22.0	7.5		† 6 15 0
Special Orchard	103	do.	do do		8.34		8.4	0.2	0.4	9.0		10.04	†10 2 6
Potato Manure	129	Eclipse	West Australian Meat Export Co., Ltd.		3.9		16.0		0.25	16.25		4.25	† 7 5 0
6. MISCELLANEOUS—													
Super and Manganese*	112	Cresco	Cresco Fertiliser (W.A.) Ltd.				17.0	0.5	1.0	18.5			† 7 10 0
B—ORGANIC.													
(a) *Blood and Bone:*													
Animal Fertiliser	1	State Abattoirs, Midland Junction	State Abattoirs, Midland Junction			8.0			5.0	5.0			†10 0 0
Blood and Bone	2	"Wyndham"	Wyndham Freezing Canning and Meat Export Works			6.0		6.0	6.5	12.5			‡10 5 0
Do.	3	Fitzroy	W. Angliss & Co. (Aust.) Pty., Ltd.			5.0		6.0	12.0	18.0			‡ 8 5 0
Do.	5	A.N.A. Surprise	C. A. Kirby & Sons			5.0		4.0	10.0	14.0			‡10 15 0
Do.	6	Apollo	J. Kitchen & Sons Pty., Ltd.			7.0				14.0			‡10 10 0
Do. (Brooklyn)	7	TB & S (in diamond)	Thos. Borthwick & Sons (Aust.), Ltd.			5.75		5.75	6.0	11.75			† 8 10 0
Do.	36	Sickle	Cuming Smith & Mt. Lyell F.F., Ltd.			5.0			15.0	15.0			†10 0 0
Do.	64	ML (in diamond)	do. do.			5.0			15.0	15.0			†10 0 0
Do.	94	CSML	do do			5.0			15.0	15.0			†10 10 0
Do. G	95	do.	do do			6.0			12.0	12.0			†10 10 0
Do. (Wyndham)	109	Cresco	Cresco Fertilisers (W.A.), Ltd.			6.25			12.0	12.0			†10 10 0
Do.	119	Albany Freezing Works, Ltd.	Albany Freezing Works, Ltd.			6.0				12.0			†10 0 0
Do.	120	A1 (in circle)	Haynes & Clements			5.25		3.0	9.0	12.0			‡10 10 0
Do.	133	Robbs	West Australian Meat Export Co., Ltd.			5.25			14.0	14.0			† 9 15 0
Do.	132	Eclipse	do. do			6.0			12.0	12.0			†10 0 0
Do.	126	Sun	Westralian Farmers, Ltd.			5.25				14.0			† 8 15 0

* Contains 5·75% Manganese as MnO_2.

FERTILISERS—*continued.*

Name of Fertiliser.	Reg. No.	Brand.	By whom Registered.	Nitrogen (N) as				Phosphoric Acid (P_2O_5) as				Potash (K_2O) as		Cash Price per ton on rails at Works † or Perth. ‡
				Nitrate.	Ammonia.	Blood and Bone.	Bone-dust.	Water sol.	Citrate sol.	Acid sol.	Total.	Sulphate.	Muriate.	
				%	%	%	%	%	%	%	%	%	%	£ s. d.
6.—MISCELLANEOUS—*continued.*														
(*b*) *Bones:*														
Bonedust	93	CSML	Cuming Smith & Mt. Lyell F.F., Ltd.				3·5			22·0	22·0			†11 0 0
Do.	110	Cresco	Cresco Fertilisers (W.A.), Ltd.				3·5			22·0	22·0			†11 0 0
Do.	130	Eclipse	West Australian Meat Export Co., Ltd.				3·5			22·0	22·0			† 7 10 0
(*c*) *Blood:*														
Dried Blood	4	Fitzroy	W. Angliss & Co. (Aust.) Pty., Ltd.			12·0								‡15 10 0
C—MINERAL AND ORGANIC.														
Bone and Super.	27	Sickle	Cuming Smith & Mt. Lyell F.F., Ltd.			2·0		13·0	0·8	4·7	18·5			† 6 17 6
Do.	55	ML (in diamond)	do. do.			2·0		13·0	0·8	4·7	18·5			† 6 17 6
Do.	75	CSML	do. do.			2·0		13·0	0·8	4·7	18·5			† 6 17 6
Special Mixture for Lawns*	37	Sickle	do. do.		6·94			3·95	0·23	5·67	9·85	6·02		†12 0 0
Do. do.*	65	ML (in diamond)	do. do.		6·94			3·95	0·23	5·67	9·85	6·02		†12 0 0
Do. do.*	96	CSML	do. do.		6·94			3·95	0·23	5·67	9·85	6·02		†12 0 0
Bone, Super. and Potash	111	Cresco	Cresco Fertilisers (W.A.) Ltd.				1·0			14·0	14·0	1·0		† 4 17 6
Special Mixture 140*	118	do.	do. do.		6·94			3·95	0·23	5·67	9·85	6·02		†12 10 0
Manurial Insecticide	8	Kill-a-Mite	Thomas Agency		2·02						3·76		2·51	
Fertos	123	Floreat	T. S. McGill		9·38			15·0	0·5	1·55	17·05			†20 0 0
B.S.P.	131	Eclipse	West Australian Meat Export Co., Ltd.		1·20			5·0		9·0	14·0		1·20	† 5 0 0

* Contains traces of magnesium, iron, copper, zinc and manganese as sulphates.

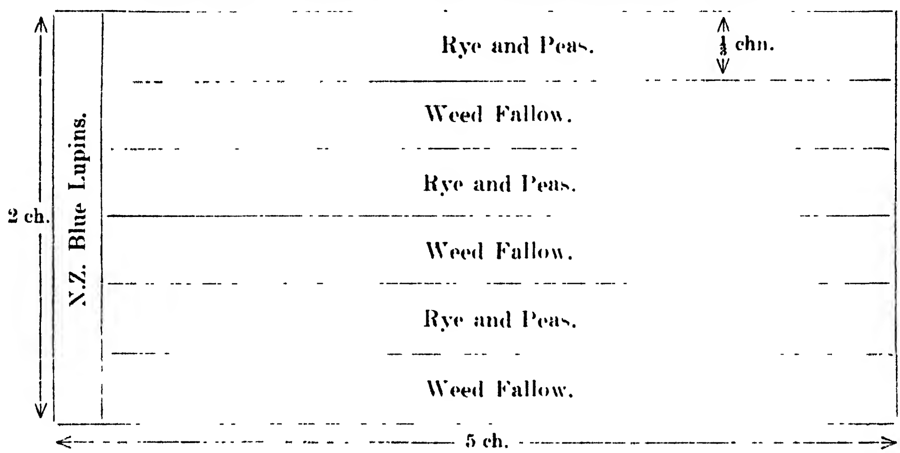
Variety and Fertiliser Experiments with Tobacco at Manjimup—Season 1938-39.

W. P. CASS SMITH, Plant Pathologist.*

A. SHARP, Tobacco Adviser.

The programme of field experiments with tobacco for the season 1938-39 was again carried out on Mr. G. F. Combs's property at Jardee, and the area utilised was that on which the previous season's experimental crop had been grown. The area, which measured 5 chains by 2 chains, was ploughed and cultivated during the third week of April, 1938, and divided into six strips each one-third of a chain wide. Alternate strips were sown on 28th April with a green manure crop consisting of a mixture of rye and field peas at the rate of 2 bushels of rye and 1 bushel of peas per acre, together with a dressing of superphosphate at the rate of one bag (180 lbs. approx.) per acre. A plot measuring 2 chains by one-third chain at one end of the area was sown with New Zealand Blue Lupin on the following day, and the remainder of the area was left unsown. The seed of each legume was inoculated with the appropriate strain of nitrogen-fixing bacteria according to Departmental recommendations.

DIAGRAM OF LAYOUT OF GREEN MANURE PLOTS.



An excellent germination of rye, peas and lupins was obtained and by the middle of August the crop was standing between three and four feet high while the unsown strips were carrying a fairly prolific growth of capeweed. The area was ploughed on the 23rd and 24th of August and then cultivated with a disc cultivator. It was cross ploughed on the 25th and the 26th of October, by which time the lupins and peas had completely decomposed and only a very little rye straw was in evidence. The ground was worked down to a fine tilth with harrows, and the furrows were opened to receive the fertilizer on the 28th of October. Except where stated otherwise 1,000 lbs. of standard tobacco fertiliser was applied per acre, the composition being as follows:—

Sulphate of ammonia	120 lbs.
Nitrate of soda	60 „
Superphosphate	700 „
Sulphate of potash	120 „

*Officer in charge of Tobacco Investigations.

Planting was completed by the 7th of November, a plentiful supply of well-grown, healthy seedlings being available from the Department's own seed-beds at Manjimup. An excellent strike was obtained, very little replanting being necessary. Continuous horse and hand cultivation was carried out throughout the growing season. Some field infection of downy mildew (blue mould) occurred early in December, but the damage done was confined to some spotting of the bottom leaves.

Climatic conditions experienced up to the middle of January were rather more favourable than usual and the crop generally promised to be an excellent one. Topping was carried out during the second week of January. It was anticipated that the harvesting of the bottom leaves would commence on the 23rd of January, but unfortunately heavy soaking rain fell on the three previous days, washing the gum off the leaves and rendering them unfit to pick. Unsettled weather was experienced until the middle of February, and the resulting thorough saturation of the soil caused a fresh flow of sap in the plants, which had the effect of reverting the almost mature leaf to an immature condition. Harvesting eventually commenced on the 27th of February, having been delayed five weeks. The effect of the extremely unusual weather conditions was to coarsen the leaf, render it rather difficult to cure, and seriously reduce the proportion of bright leaf which might otherwise have been obtained.

Five pickings were obtained at weekly intervals, the final picking being made on the 27th of March; by this time low night temperatures were definitely exercising a detrimental effect on the leaf. As each cure was completed the leaf from each plot was carefully labelled and placed in bulk where it remained until the third week in June. The leaf from each plot was then weighed, graded, and the weight and estimated value per lb. of each grade recorded.

Green Manuring.

Throughout the season careful note was made of the effect on the tobacco of the green manure crops. As the season progressed it became obvious that the crop growing on land where lupins had been ploughed in would be extremely heavy. However, this crop did not mature normally, the leaf retaining its dark green colour until late in the autumn when it tended to perish from the tips backward. As was to be expected, it was impossible to cure this leaf a good colour and it was of no commercial value. It has previously been noticed on several occasions that maturity and quality are adversely affected when tobacco is grown immediately after lupins, and it is reasonable to assume that this effect is due to the fixation of excessive quantities of nitrogen by this legume.

It is possible therefore that in such cases normal maturation and quality would be obtained by considerably reducing the amount of applied nitrogenous fertilisers, a point worthy of further investigation, especially at the present time when available supplies of these fertilisers are limited.

The difference between the crop grown on soil in which rye and peas had been planted and that on weed fallow was less than was anticipated. If anything, the green manured area produced a more even growth of tobacco, but the total yields and leaf values from the two treatments did not differ significantly. However the unseasonable weather experienced just as the crop approached maturity may have obscured any effect of treatment.

Variety Experiment.

The following eleven varieties were included in this experiment:—

1. *Hickory Prior.*—Standard variety in this State for a number of years.

2. *Gold Dollar.*—Popular in Queensland. Not previously grown in Western Australia.

3. *Kelly.*—Introduced three years ago from New South Wales. Has given very promising results here.

4. *Cash.*—Introduced five years ago from America. Has previously given excellent results and is popular with growers.

5. *Bonanza.*—Introduced three years ago from Queensland and has given good results.

6. *Dungowan.*—Being tested here for the first time. Largely grown in Victoria owing to supposed resistance to Blue Mould.

7. *Dungowan Selection.*—An improved strain of Dungowan.

8. *No. 35 White Stem Orinco.* -Newly introduced from America.

9. *Yellow Mammoth.*
10. *White Mammoth.* } Both these are newly introduced from America.

11. *Harrow Velvet.*—A light Burley variety suitable for air curing. Newly introduced from America.

The experiment was arranged in the form of a randomised block with four separately randomised replications of each variety Each plot consisted of 20 plants spaced at 2 ft. intervals in rows 4 ft. apart. Half of each plot was planted in soil green-manured with rye and peas and half on weed fallow. Standard tobacco fertiliser was applied in the rows at a depth of approximately four inches at the rate of 1,000 lbs. per acre. The plants were set out on the 31st of October.

About the end of November slight infection by downy mildew (blue mould) was observed on all varieties, the burley variety "Harrow Velvet" appearing, if anything, to be the most susceptible to this disease. "Dungowan" and "Dungowan Selection" showed infection to an extent about equal to the other varieties, but the incidence of the disease was much too slight to enable any opinion to be formed regarding their ability to resist serious attack

All varieties made good growth. "Dungowan" and "Dungowan Selection" were particularly vigorous, but produced very large, coarse leaf which failed to mature normally and refused to cure a good colour. In view of this fact, these varieties are regarded as being unsuitable for cultivation in this State. As field mould has seldom proved to be serious here, the supposed resistance of these varieties to this disease does not make up for their lack of quality under our conditions.

"Harrow Velvet" being a burley variety suitable for air curing, cannot be compared with the flue cured varieties. It is interesting to note, however, that it produced a moderate crop of leaf which, when cured, developed fairly typical burley aroma and smoking qualities. It is understood that there might be a definite, though limited, market in Australia for good quality burley leaf. As it appears to be particularly susceptible to the ravages of downy mildew it is unlikely that it can be grown successfully in the Eastern States where field infection is much more serious than it is here, so that any development of this type of tobacco is most likely to take place in W.A.

There was no significant difference in total yield of leaf between the remaining eight varieties.

Grading was carried out during the second week in July, and as the suitability of any variety depends not only on total yield, but on leaf quality also, the value of the marketable leaf was estimated according to commercial standards. The estimated value of the graded leaf was then used as a basis for calculating

results. It was found that the variability of values between individual plots of the same variety was great, this probably being due in great measure to the unfavourable weather experienced during January and February. This variability may have obscured the results of the trial, but it can be said that the new varieties "Gold Dollar," "Yellow Mammoth," "White Mammoth" and "No. 35 White Stem Orinoco" all showed definite promise and appeared to be capable of giving satisfactory yields of high quality leaf. Of these, the two latter were the best varieties, but all will be subjected to further trial during the forthcoming season.

Samples of leaf of all varieties were submitted to the Council for Scientific and Industrial Research and to three firms of tobacco manufacturers for smoking tests. At the time of writing one report has been received from an Eastern States' firm which gives the following opinions:—

"Hickory Pryor" is a good *tobacco* type, burning very slow.

"Bonanza," a good *cigarette* type with good smoking qualities, bad burning.

"Yellow Mammoth" and "White Mammoth," good *cigarette* types with good smoking qualities but very slow burning.

"Gold Dollar," "Cash" and "White Stem Orinoco," good smoking qualities, burning slow.

"Kelly" is not very attractive.

Minor Element Experiment.

Object. To study the effect on growth and quality of leaf of:—

(a) Various minor elements when added singly to the control fertiliser.

(b) Various minor elements when added jointly to the control fertiliser.

(c) To test the possibiltiy of reducing the amount of control fertiliser by the addition of a complete dressing of minor elements.

The experiment consisting of 10 treatments was arranged in the form of a randomised block with four separately randomised replications of each treatment. Treatment rows consisted of 20 plants spaced at 2 ft. intervals, the rows being 4 ft. apart. Half of each row was planted on green-manured land and half on weed fallow. The variety planted was "Hickory Pryor."

The treatments were as follows:—

1. (Control). Standard tobacco fertiliser, 1,000 lbs. per acre.
2. Control plus sulphate of iron at 20 lbs. per acre.
3. Control plus magnesium sulphate at 20 lbs. per acre.
4. Control plus copper sulphate at 20 lbs. per acre.
5. Control plus zinc sulphate at 20 lbs. per acre.
6. Control plus manganese sulphate at 20 lbs. per acre.
7. Control plus cobalt chloride at 5 lbs. per acre.
8. Control plus borax at 5 lbs. per acre.
9. Control plus complete mixture of above "minors."
10. Half the amount of control fertiliser plus complete mixture of "minors."

The fertiliser was applied in the furrow about four inches deep, and the plants were set out on the 4th of November. By the 16th of November all plots were looking well except Treatments 7 and 8 (cobalt and boron) which were rather backward in coming away. By the beginning of December, Treatment 5 (zinc) was definitely ahead of all others on all four blocks, while Treatments 7 and 8 were still most backward. Little or no difference could be observed between the other treatments at this stage. By the 10th of January, the plots treated

with magnesium (Treatment 3) appeared to have made the best growth, while Treatment 5 (zinc) was no longer outstanding. At this stage the cobalt and boron treatments appeared to have recovered from their initial setback and were as well grown as the controls.

It was noteworthy that Treatment 10 (half control plus complete mixture of "minors") had made at least as good growth as the controls, and there was no apparent difference between Treatments 9 and 10, both of which received a complete mixture of "minors."

Analysis of the total yields of cured leaf obtained showed no significant difference between treatments. This indicates that the application of only 500 lbs. per acre of standard tobacco fertiliser plus the complete mixture of "minors" was as good as 1,000 lbs. per acre of standard tobacco fertiliser alone.

Unfortunately, owing to the limited area of land available for this experiment no direct comparison was made between 500 lbs. and 1,000 lbs. per acre of standard tobacco fertiliser (Treatment 1), but an analysis of the leaf value showed that the latter was only exceeded by 1,000 lbs. of standard mixture plus all "minors" (9), while neither differed from 500 lbs. of standard mixture plus all "minors" (10).

The fact that all "minors" except boron, zinc, and manganese had a depressing effect on leaf value, when added singly to the standard mixture, may indicate the cause of the response to (9) and (10), but this is by no means certain.

There is no doubt that the weather conditions experienced just before harvesting commenced, adversely affected the results of this experiment, but in view of the important indications obtained the experiment is being continued on a more elaborate scale this season.

Samples of leaf from all treatments were submitted to the C.S.I.R. and to three firms of tobacco manufacturers for smoking tests. To date one report has been received from an Eastern States firm which states that there is no detectable difference between the various samples, and that, so far as smoking quality is concerned, the use or otherwise of "minor" elements, with or without a reduction in the application of tobacco fertiliser is purely a matter of economics.

Organic Nitrogen Experiment.

Object. To determine whether replacing the sulphate of ammonia fraction of inorganic nitrogen in standard tobacco fertiliser with organic sources of nitrogen is of advantage to the tobacco crop.

The sources of organic nitrogen were (a) fish manure, (b) dried blood, (c) stable manure, and the amounts used to replace the sulphate of ammonia contained respectively equivalent quantities of nitrogen.

The experiment consisted of four treatments with four separately randomised replications, and it was planted on the 4th of November with plants of the "Kelly" variety.

There was no obvious difference between treatments during growth, and analysis both on the basis of total yield and of leaf value, showed no significant differences. This confirms the results obtained from the four previous trials, and it can be assumed that no advantage is obtained by substituting any of the above sources of organic nitrogen for the inorganic sulphate of ammonia contained in the standard tobacco fertiliser used in this State. A large number of smoking tests have been carried out by the C.S.I.R. on samples of leaf obtained from this experiment over four successive years, and these also have shown no effect of treatment so far as smoking quality is concerned.

Potash Experiment.

Object. To determine the effect of different rates of application of potash on the yield and quality of tobacco leaf.

The rates of potash used were as follows:—

Treatment 1. As in standard tobacco fertiliser at 1,000 lbs. per acre (= 120 lbs. sulphate of potash).

Treatment 2. Potash increased by 100 per cent.

Treatment 3. Potash reduced by 50 per cent.

Treatment 4. No potash.

The experiment was arranged in the form of a randomised block with four separately randomised replications, and was planted on the 14th of November, the "Gold Dollar" variety being used.

There was no obvious difference between treatments during growth and ripening, but analysis of the total weights of leaf obtained showed that Treatment 2 (increased potash) was better than Treatments 3 and 4 (reduced potash and no potash respectively), but did not differ significantly from Treatment 1. This indicates that the use of potash is beneficial and that the most effective level is between 120 lbs. and 240 lbs. of sulphate of potash per acre.

This experiment has now been carried out over a period of five years and during this time numerous samples of leaf have been tested for smoking quality by the C.S.I.R.; however, no significant differences between treatments have as yet been detected.

Superphosphate Experiment.

Object. To determine the effect of different rates of application of superphosphate on the yield and quality of tobacco leaf.

The rates of superphosphate used were:—

(a) As in standard tobacco fertiliser at 1,000 lbs. per acre (= 700 lbs. super per acre).

(b) Super increased by 50 per cent.

(c) Super reduced by 50 per cent.

This experiment has also been carried out over a period of five years, and this year it consisted of three treatments with four separately randomised replications. Planting was carried out on the 7th of November with the "Yellow Mammoth" variety. Analysis shows no effect of treatment.

Damage was done to some of the plots by rabbits shortly after planting and this, together with the unfavourable weather experienced just before harvesting caused great variations in yield and value as between the replications; these factors may thus have obscured any results separable under normal conditions. The results obtained in previous seasons, however, have indicated that a reduction in the application of superphosphate has caused a lowering in both yield and quality of leaf.

Inorganic Nitrogen Experiment.

Object. To determine whether it is better to supply nitrogen to tobacco plants in the form or nitrate of soda or sulphate of ammonia.

This experiment has been carried out over a period of three years and this year it consisted of three treatments with four separately randomised replications. Planting was carried out on the 7th November, the variety used being "Yellow Mammoth."

Rabbits destroyed a number of plants in this experiment also, and the results obtained were therefore not regarded as reliable. The results of previous seasons' experiments, however, have indicated that a mixture of nitrate of soda and sulphate of ammonia as supplied in the standard tobacco fertiliser gives more satisfactory results than does the same amount of nitrogen supplied wholly in either one of these forms.

ACKNOWLEDGMENTS.

The authors are greatly indebted to Mr. S. L. Kessell (Conservator of Forests) for making available the services of his Statistical Branch for the purpose of assisting with the statistical analysis of the results.

A Record of a New Noxious Weed, and a Warning to Farmers and Settlers.

RAPISTRUM WEED.

(Rapistrum rugosum (L.) All.)*

C. A. GARDNER.

A specimen recently received from Nangetty Station, near Mingenew, has been identified as *Rapistrum rugosum* (L.) All. This plant, now recorded as a new addition to the naturalised flora of Western Australia, belongs to the Cruciferae, and adds still another of the undesirable plants of this family which provides so many of our serious weeds that from time to time are introduced into this country, and which find here conditions favourable for their spread. This plant, here illustrated for the information of farmers and settlers, is, as far as we know at present, confined to two areas—Nangetty Station and the adjacent roadsides, and Marchagee Station on the Midland Railway. That it has been present in the former locality for some years is evident; that it is spreading is also evident, and it is to be hoped that a careful watch will be maintained so that remedial measures promptly undertaken, may result in this pest being controlled and ultimately destroyed before it has an opportunity to spread.

We are most of us familiar with the history of the spread of the wild turnip in Western Australia, which, as one of the most serious weeds of wheatfields, has caused considerable losses and hardships, and of which the rapidity of spread is unequalled by any other introduced weed. The wild turnip was originally introduced into the Nangeenan district about the year 1914, but it was not until 1925 that it caused any concern, and from the latter date its spread has been such that it has invaded practically the entire wheatlands of Western Australia.

It is a well known fact that many weeds after introduction into a new land may develop very slowly for several years, perhaps becoming acclimatised, and then quite suddenly and unexpectedly assume seriously aggressive habits, and spread alarmingly. Saint John's Wort is an example in Victoria, and the Wild Turnip

*Derived from rapum, the Latin name of the turnip; rugosus, wrinkled, referring to the roughened seed vessels.

and Cape Tulip are excellent local examples. Rapistrum weed has already been here for at least twelve years, and it was not until this year (1939) that, probably due to very favourable conditions for the germination of its seeds, it spread at Nangetty from an area of a few acres to almost five hundred. From its original place of establishment—the Nangetty sheep yards—it has spread over this area, and is now along the roadsides for about ten miles towards Mingenew, occurring it is true in a sporadic fashion, but even next year it may develop gregariously. And it is this occurrence along the roadsides that should give cause for concern; it has evidently been deposited there by travelling sheep, and it is from roadsides that it can most readily invade cultivated land, and also be still further carried by travelling stock to other districts. The call for action on the roads is therefore urgent. The other centre of infestation—the railway yard at Marchagee—is one from which one might expect the seeds to be readily carried into the district. These two localities are given so that farmers nearby may be on the watch for the plant.

Rapistrum weed is already naturalised in Victoria and South Australia, where it is spoken of as the "Wild turnip—a bad weed of wheatfields." The name "Wild turnip" of course cannot be applied to the plant here, since it is already given to *Brassica Tournefortii*. The reputation which Rapistrum has in other places would be equally true for Western Australia should the weed spread to any extent, for it combines the undesirable features of both the wild radish and the wild turnip. Most of its seeds are, like those of the wild radish, enclosed in seed-vessels that do not liberate their seeds, and thus, especially when buried by cultivation, retain their powers of germination for several years. On the other hand it has the tall stature, the free seeding habit, and the somewhat brittle stem bases of the wild turnip, and wind may be an important factor influencing its spread.

Rapistrum rugosum is a Noxious Weed for the State of Western Australia by Government Proclamation, and as such it is the duty of all concerned to destroy the plants wherever they are found. The local authority (the Road Board) is responsible for the enforcement of the Noxious Weeds Act in its district, and a closer co-operation between farmers and the local authority is desirable in the interests of the farming community.

As with all annual weeds, the essential feature of control is the prevention of seed formation, hence it is necessary that plants should be destroyed before flowering has advanced. Any action taken afterwards is useless. Plants on roadsides may be destroyed by pulling or grubbing at least earlier than the full flowering period, and destruction by burning; plants in arable land may be destroyed in a similar manner, or, when too numerous for individual treatment may be cultivated, or kept in check while young by a sufficiently heavy grazing by sheep which will eat the plants with avidity in the young stages of growth

Description of plant.

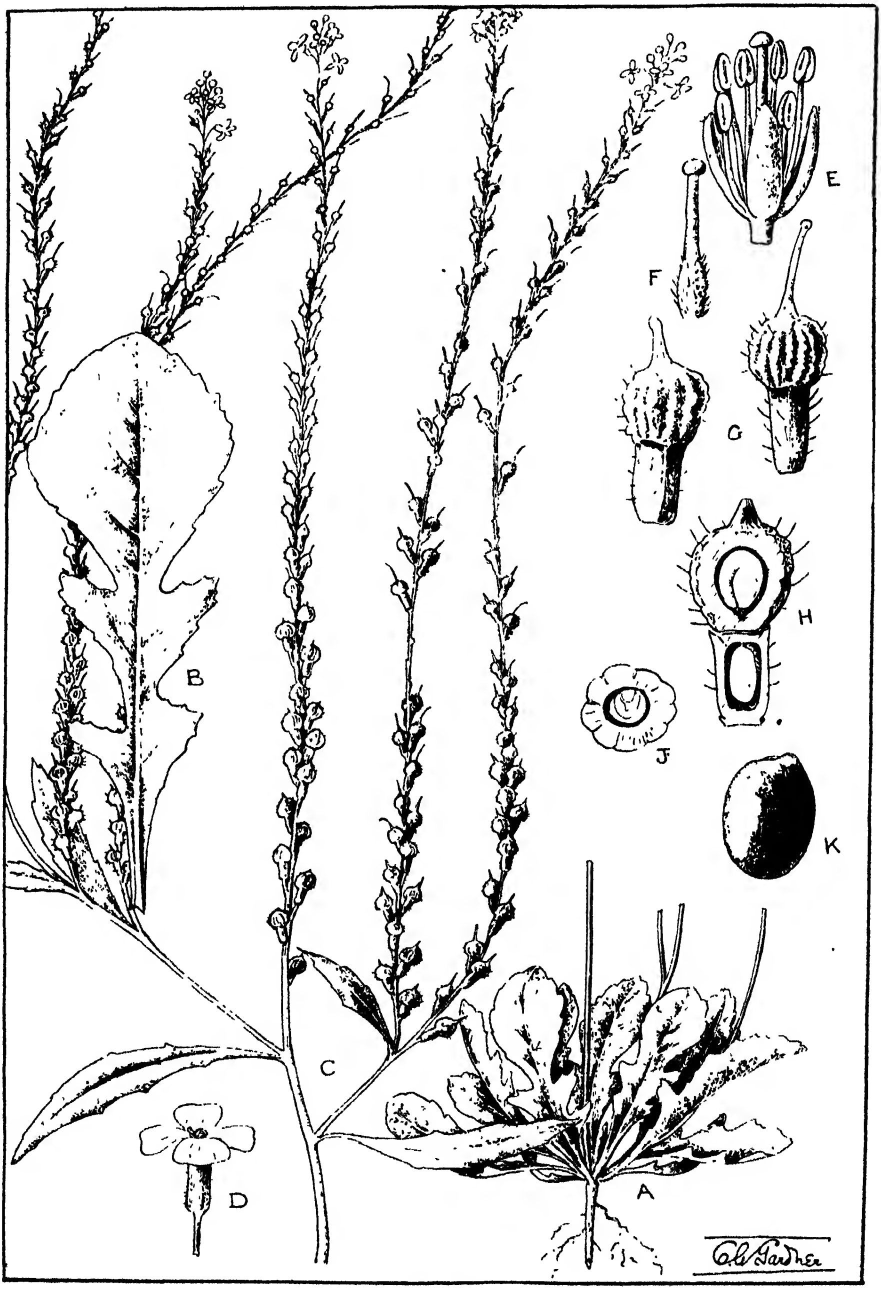
Annual; stems erect, 1-2 metres (3-6 feet) high, branching from the base or rarely simple, much branched upwards, the branches ± flexuose, erect or spreading, the stems hard and wiry when mature, and usually weakening at the base at seeding time, hispid when young, but becoming glabrous and violet-coloured with age. Basal leaves clustered, petiolate, lyrate-pinnatisect with 2-4 pairs of lobes usually unequal, the terminal lobe the largest, suborbicular to ovate or obovate, shortly and coarsely toothed, obtuse; lateral lobes oblong-ovate, obtuse, with a few teeth, the lowest much smaller, triangular, subentire; upper leaves subsessile, entire or minutely toothed, ± hispid. Racemes at the time of flowering dense, becoming elongated in fruit, 30-150-flowered; pedicels filiform, glabrous. Sepals erect-

spreading, 4-5 mm. long, the outer linear, the inner oblong, hispid, especially towards the apices; petals yellow, obovate, clawed, obtuse or truncate, faintly violet-nerved; stamens 6; pistil cylindrical, biarticulate, the lower article 1 mm. long with one pendulous ovule (rarely 2 or 3); the upper article with one (rarely more) erect ovule; both articles densely hirsute; styles glabrous; stigma broad. Fruiting pedicels erect, almost appressed, 2-6 mm. long. Fruit biarticulate, 8-10 mm. long, the lower article 2.5-3 mm. long, oblong, terete, 1.5 mm. diameter, slightly

RAPISTRUM WEED

ribbed, tardily dehiscing by two valves, normally one-seeded, very rarely slender and 2-3-seeded. Upper article much broader, globular, 3-5 mm. diameter, longitudinally ribbed, 1-seeded, indehiscent, terminating in a short or long beak which is rarely deficient with age. Seed in the lower article pendulous, ovoid or oblong-cylindrical; seed in the upper article erect, ovoid, usually larger than the seed of the lower article, yellowish-brown, smooth and shining.

Flowering August-November; fruiting September-December. Original home Europe. Naturalised in Germany, Southern France, Italy, Spain, North Syria, Madeira, Teneriffe, South America, Australia.



RAPISTRUM WEED.

(*Rapistrum rugosum* (*L.*) *All.*)

EXPLANATION OF PLATE:

A, basal portion of young plant. *B*, leaf (less than natural size) from the basal cluster. *C*, portion of inflorescence showing lengthening, with flowers at the apices; young fruits, and mature fruits towards the base. *D*, flower (enlarged). *E*, flower with the petals removed. *F*, gynœcium. *G*, fruits. *H*, section through much enlarged fruit showing the two articles—the upper globular article with erect seed, the lower with smaller pendulous seed, and the point of disarticulation. *J*, transverse section of the upper article of the fruit. *K*, seed (much enlarged).

—*Original drawing. Ninghan, near Mingenew. November*, 1939.

Brown Spot, a Serious Disease of the Passion Vine.

W. P. CASS SMITH, Plant Pathologist.

The common passion vine (passiflora edulis) has been grown in Western Australia for many years, but the acreage under cultivation has only increased slowly; according to the best available information the area under crop for the 1938-39 season, was approximately 100 acres.

A lack of suitable soil types or congenial climatic conditions is certainly not responsible for this slow expansion in area for on a small scale the passion vine is successfully grown in many widely separated districts throughout the lower South-West portion of the State.

Undoubtedly this position is very largely due to two main factors, firstly marketing difficulties which make the disposal of commercial crops a rather uncertain matter, and secondly diseases, which during recent years by seriously reducing the productivity of many vines have had an important bearing on the acreage cropped.

In November this year an opportunity occurred for the writer to visit North Dandalup, Keysbrook, and other major passion vine growing areas, and during this inspection a serious disease was noticed which symptomatically appeared to be identical with Brown Spot as described by Simmonds. (1) Isolations made subsequently from infected leaves and stems confirmed this diagnosis.*

The following information compiled from observations made by the writer and by various members of the Horticultural Branch and also from experiments conducted elsewhere is briefly recorded, with the hope that it may be of advantage to growers, many of whom are extremely puzzled by this disease.

Symptoms and Effects.

Brown Spot may attack all the above-ground parts of the vine. On the leaves infection first becomes evident by the appearance of small brown spots which under favourable conditions enlarge in a more or less circular manner, gradually developing lighter coloured central areas. (Plate 1.) The spots may enlarge until they are from one quarter to half an inch in diameter or occasionally larger, and from one to several spots may occur on a single leaf.

After infection the leaves usually become paler, and fall very readily.

On the branches, dark brown lesions appear which gradually elongate to a length of one to several inches, and frequently during elongation they extend in width till the branch is completely encircled. (See arrow, plate 2.)

When this occurs the sap flow is obstructed, causing the death of all distal portions of the branch. The sudden wilting of fruits (Plates 2 and 3) on a recently cinctured branch, is an obvious symptom by which the disease can often

*Opportunity has not yet occurred to prove pathogenicity by artificial inoculation, but the species of Alternaria isolated shows sufficient agreement in cultural characters with those described by Simmonds (1) and (2) for the writer to be certain that it is the pathogen.

Brown Spot of the Passion Vine has not previously been described from this State but in all probability it has been present for several years. "Anthracnose" caused by Gloeosporium fructigenum was recorded in 1936 (3).

Although "Anthracnose" may occur here as a separate disease, it has not yet been noticed by the author; Gloesporium sp. are however frequently associated with the older parts of Brown Spot stem lesions, but not invariably so.

The control measures previously recommended for "Anthracnose" were quite applicable for Brown Spot and when fully adopted they have given excellent results.

be detected in vines which may otherwise appear quite healthy; in many cases the affected branch must be traced back several feet before the causal lesion is discovered.

It is also noticeable that the leaves on such a branch remain fresh and green for some time after wilting of the fruit commences.

Plate I

Passion vine leaves infected with Brown Spot (*Alternaria passifloræ*).*

[*Photo by Govt. Photographer.*]

Brown Spot may also attack fruit producing brownish spots which as they enlarge gradually become depressed and more or less circular in outline. (Plate IV.)

Fruit is frequently infected on the cheek but it may also be attacked at the stalk end, or at any other point.

It will be seen therefore that the productivity of the vines is seriously lowered by the disease, for not only may fruit be attacked directly, but through causing defoliation and dieback of branches, the vigour of the vine is so depleted that the crop is considerably reduced.

When vines are badly attacked by Brown Spot, almost total defoliation may occur, and tangled masses of dead stems are noticed. In such cases the effect may be so severe that the vines ultimately die.

Cause of the Disease.

Brown Spot is caused by the fungus *Alternaria passifloræ*, and it is spread by means of fungal seeds or spores which are produced abundantly from the surface of any diseased parts; spore production may continue for long periods after the affected parts are killed.

The spores are carried by wind, or splashed by rain, and by these means some will eventually lodge on other healthy vine parts, where in the presence of moisture and with sufficient temperature they germinate and cause new infections.

Factors Affecting the Spread of the Disease.

Pruning.

Of all factors affecting the disease, pruning is by far the most important. Where pruning is systematically carried out as an annual procedure the occurrence of the disease is noticeably reduced, even in the absence of any other control measure. When the vines remain unpruned, they gradually develop into an impenetrable mass of foliage and runners and in this condition any diseased parts remain in close contact with still healthy parts; furthermore, light and air are excluded, and in consequence the tangled growth remains wet for long periods after rain, thus providing ideal conditions for the spread of the disease.

Plate II.

Passion vine branch recently cinctured by the Brown Spot fungus (at point indicated by arrow). Death of all distal portions of the branch will ultimately occur.

[*Photo by Govt Photographer.*]

For this reason it is readily observed on most properties where pruning has been neglected, that the youngest vines with relatively sparse foliage are comparatively healthy, whereas in older vines with more abundant growth, the disease is more widespread.

Judicious pruning stimulates the vine to healthy vigorous growth and greatly increases its productive life; it also enables all diseased parts to be removed and burned during the process, thus destroying the sources of infection.

Plate III.

Wilting of fruit on a cinctured branch is a symptom by which Brown Spot can frequently be easily detected. The affected branch may have to be traced back several feet before the causal lesion is discovered.

[*Photo. by Author.*]

Furthermore, air and light can penetrate to all parts of the pruned vine, which allows the foliage to dry quicker after rain, thus preventing the germination of the fungal spores.

The time of pruning will vary with local conditions, and with the kind of crop which is desired, either summer, intermediate or winter. In the Keysbrook and North Dandalup districts, it is the custom of the leading growers to prune

early in March, after the main summer crop is harvested. By so doing a late winter and intermediate crop is also obtained which varies in yield with the season and with the character of the previous summer crop.

When a heavy winter crop is desired, pruning is delayed until the summer crop is about half grown.

Climatic Conditions.

Brown Spot is favoured by warm moist weather, and so in normal seasons the disease is most serious during the Spring and early Summer months.

Although as yet there has been little opportunity to study accurately the seasonal incidence of the disease, observations indicate that Brown Spot, though

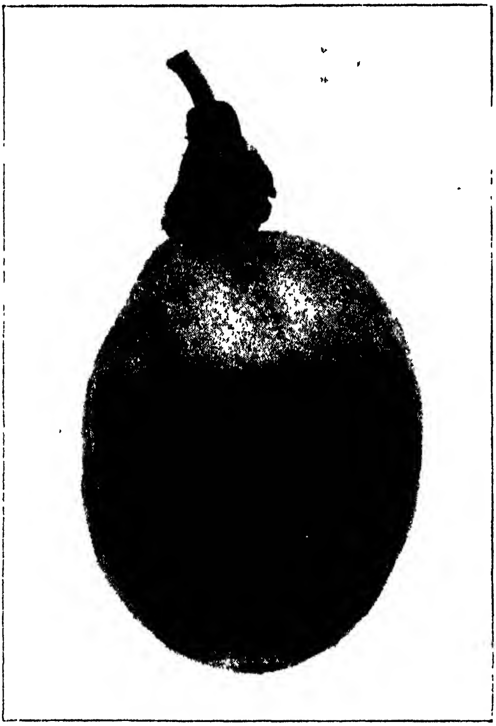


Plate IV
Fruit Attacked by Brown Spot
[*Photo by Govt. Photographer.*]

present during winter, does not usually become very active at this stage as the temperatures are low; from August to December, especially with high rainfall it may gradually increase in seriousness and spread very rapidly.

Unless unseasonable summer rains subsequently occur, the weather then becomes hot and dry, and in consequence the spread of the disease is limited until the Autumn rains commence.

Spraying.

Where systematic pruning is carried out annually, applications of a suitable fungicidal spray will effectively control this disease. It should be remembered however that the main purpose of the spray is to cover still healthy parts in order to prevent the disease from spreading, and that unless the vines are kept well pruned this object cannot be achieved and spraying is therefore ineffective.

Of all the common fungicides, home-made Bordeaux Mixture, plus a suitable spreader, has given the best control, and where the disease is present the cost of spraying will be repaid many times over.

Care should be taken to apply the spray on a fine day when it will dry quickly otherwise severe burning may be caused.

Control.

(1) Train the passion vine systematically from the commencement of growth, keeping the main runners well tied to their respective trellis wires, in order subsequently to facilitate pruning.

(2) Prune the vines well back at least once a year at a time determined according to whether a summer, intermediate or winter crop is desired.

The more freely light and air can penetrate through the vines within limits, the less serious will the disease be. All diseased lesions should be cut out during this operation, and all prunings should be burned as quickly as possible.

(3) Spray the vines after pruning with home-made Bordeaux Mixture 4: 4: 40 strength + a suitable spreader. (See Leaflet 314 which is free on application to the Department of Agriculture.)

Repeat the spraying at monthly intervals during the spring and early summer months, and thereafter at two monthly intervals if required by the season. When mature fruit are are on the vine, ammoniacal copper carbonate may be substituted for the Bordeaux Mixture in order to avoid discolouration.

(4) Periodically examine all vines to detect any newly formed lesions and destroy them before they become a source of infection to other shoots or vines.

(5) Artificial waterings, if any, should be reduced to a minimum, and in home gardens overhead watering should be discouraged.

Acknowledgment.

The author gratefully acknowledges the assistance he has received in connection with this disease from investigations carried out in Queensland, which have been reported from time to time in the Queensland Journal of Agriculture, by J. H. Simmonds, M.Sc.

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(1) Simmonds, J. H.: Brown Spot of the Passion Vine. Queensland J. of Agric., Dec., 1930, pp. 564-585.

(2) Simmonds, J. H.: *Alternaria passifloroe* n. sp. the Causal Organism of Brown Spot of the Passion Vine. Proc. of the Roy. Soc. of Queensland, Vol. XLIX., pp. 150-151.

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Associations for the Improvement of Dairy Herds in Western Australia.

REPORT FOR YEAR ENDING 30th APRIL, 1939.

G. K. BARON-HAY, Superintendent of Dairying, and G. SLATER.

The season commencing May, 1938, was a favourable one for the production of dairy produce, the usual autumn rains being regular without extremes of monthly rainfall or temperatures.

More applications were received for the formation of new Units than could be approved and commenced with the funds which were available, but it was possible to commence six new Units at Bridgetown, Metricup, Ruabon, Northcliffe, Cowaramup, and Narrogin respectively.

The average production of those cows under test in the scheme is shown in Table 1 below and includes the productions of all cows which were under test for three months or more.

TABLE 1.

AVERAGE PRODUCTION PER COW.

No. of Herds.	No. of Cows.	Milk.	Test.	Butter Fat.
		gals.	%	lbs
485	12,368	487	4·48	218 7

This average production of butter fat is approximately the same as for the previous year 1937-38, showing a reduction of only 4 lbs. per cow. In view of the inclusion of the six new Units with an average production of 193 lbs. butter fat per cow, this average production is considered satisfactory.

That the maintenance of this production is not entirely due to seasonal conditions is shown by the steady improvement each year since grade herd recording was initiated in 1933-34 as is seen in the following Table 2, which indicates clearly that testing is a great factor in rapidly effecting improvement in low producing herds and assisting the farmer in maintaining these increased yields.

TABLE 2.

AVERAGE PRODUCTION PER COW, 1934–1939.

Year.	No. of Cows.	Milk.	Test.	Butter Fat.
		gals.	%	lbs.
1933–34	4,038	415	4·35	180·6
1934–35	4,088	456	4·56	207·8
1935–36*	4,590	459	4·51	207·3
1936–37†	9,115	434	4·53	196·7
1937–38*	10,033	486	4·59	223·1
1938–39‡	12,368	487	4·48	218·7

* 1 new unit. † 9 new units. ‡ 6 new units.

It is interesting to note that, as in previous years, the average production of herds upon their entry into the herd recording scheme is below 200 lbs. of butter fat per cow, which is considered the minimum for profitable and safe butter fat production, but it is confidently anticipated that the six new Units which averaged 193 lbs. butter fat per cow will have exceeded the minimum safe production by the end of the next testing year and should continue to increase thereafter.

Because of the regularity with which cows in new Units average between 180 and 190 lbs. butter fat per cow over a number of years, it appears that this figure may be taken as a reliable estimate of the average production of dairy herds outside the scheme.

Production per Cow in each Unit.

The average production per cow in each Unit is shown below in Table 3:—

TABLE 3.

Unit.	No. of Herds.	No. of Cows.	Percentage of Heifers.	Milk.	Test.	Butter Fat. 1938–39.	Butter Fat. 1937–38.
				lbs.	%	lbs.	lbs.
A. Donnybrook ..	29	628	16	4,769	4·83	230·10	275 18
B. Serpentine	16	335	14	5,452	4·34	236 90	236 93
C. Cookernup	21	750	25	5,599	4·50	252·05	230·83
D. Harvey	20	489	19	5,355	4·56	244·42	219 69
E. Brunswick	21	654	20	5,967	4·76	284·37	253 15
F. Dardanup	24	768	11	4,832	4·49	216 94	192 98
G. Capel	18	679	14	5,166	4·30	222·18	222·66
H. Balingup	25	760	16	5,572	4 71	262·10	243·06
I. Forest Grove ...	22	433	14	5,152	4·66	240 58	211·82
J. Pemberton ...	19	308	12	5,156	4·74	244 76	204·49
K. Rosa Brook ...	25	548	19	4,668	4·74	221·57	224 33
L. Vasse	18	461	8	4,090	4·36	171 91	229·59
M. Manjimup	25	579	11	4,614	4·53	209 19	214·28
O. Benger	19	551	11	5,332	4·38	233·67	233·25
P. Coolup-Pinjarra ...	20	551	8	4,271	4·63	218·20	210·01
Q. Greenbushes ..	22	485	16	4,530	4 90	222·19	217·35
S. Albany	20	402	23	4,595	4 28	196·83	185·46
T. Bridgetown ...	22	657	13	4,183	4·41	184·76	...
U. Metricup	22	490	23	5,048	4·95	250·36	...
V. Ruabon	20	564	11	4,240	4·46	188·97	...
W. Northcliffe	25	552	15	4,078	4·43	180·89	...
X. Cowaramup ...	19	442	16	4,245	4·60	195·45	...
Y. Narrogin	13	282	30	3,766	4·36	164·04	...

It will be seen that of the 23 Units embracing over 12,000 cows under test, no less than 16 averaged over 200 lbs. butter fat per cow, the highest production being that of 284.4 lbs. butter fat per cow in the Brunswick Unit.

The great value of herd recording to dairy farmers is shown more clearly by examining the average production of six representative Units which are shown in Table 4, and briefly discussing the means by which increased productions have been obtained.

In Table 4 the average productions of the Units at Donnybrook, Cookernup, Brunswick, Dardanup, Capel and Balingup since 1933-34 are shown—

TABLE 4.

IMPROVEMENTS IN SIX REPRESENTATIVE UNITS.

Herd Testing Unit.	Butter Fat.					
	1933-34.	1934-35.	1935-36.	1936-37.	1937-38.	1938-39.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Donnybrook	219·5	266·8	265·1	235·79	275·18	230·10
Cookernup	160·4	183·5	191·9	195·23	230·83	252·05
Brunswick ..	169·2	206·0	217·2	231·32	253·15	284·37
Dardanup .. .	188·6	192·2	168·2	180·73	192·98	216·94
Capel	182·9	203·1	221·1	209·96	222·66	222·18
Balingup . ..	174·6	212·4	196·3	212·78	243·06	262·10

One feature which all these Units, except Donnybrook, have in common is that, when herd recording was commenced, the average production of cows was considerably below the 200 lb. mark which is the minimum regarded as profitable, productions ranging from 160 lbs. butter fat per cow in the Cookernup Unit to 188 lbs. per cow in the Dardanup Unit.

In the case of the Donnybrook Unit, dairy farming is combined with general mixed farming, including fruitgrowing, and the system there has been to calve cows as early as possible in the autumn so that they may be dried off in January so as not to interfere with the work of picking and packing fruit. Furthermore, the herds in this district were above the average as far as breeding is concerned and mainly of the Jersey breed.

It will be noticed that this Unit has always shown productions considerably above the economic minimum but that the productions have fluctuated up and down from year to year between 220 and 275 lbs. butter fat per cow, and it will be noticed further that in other Units the maximums which have been reached are within these same limits, except in the case of Brunswick which last year had the fine average of 284 lbs. butter fat per cow.

It is found in practice extremely difficult for whole Units embracing 500 to 700 cows to maintain an average production of 250 lbs. butter fat consistently, by reason of the extreme difficulty in obtaining pure bred bulls with a sufficiently high butter fat backing to increase yields above this figure. This difficulty is shown by reason of the fact that during 1938-39 the average production of all pure bred cows submitted for official test was approximately 292 lbs. butter fat per cow.

The steady increase in production in the Cookernup and Brunswick Units calls for special mention, the means by which this increase has been obtained being a general improvement in dairy farm husbandry, such as by increasing the number of cows calving early in the season, increasing fodder conservation, the elimination of very low producers, and by the selection of the best young stock for the replacement of inferior cows. The problem facing these Units now is to maintain the high average production which was achieved last year.

The Dardanup Unit which at present is approaching a satisfactory basis as far as production is concerned has shown disappointing results for a number of years. These productions, however, have not been due to any special inferiority in the capacity of the dairy stock, one of the causes being a very low percentage of cows calving early in autumn.

Stack silage on Mr D. Semple's farm, Pemberton Approximately 75 tons per annum is conserved, using labour saving devices

During 1937-38 only 29 per cent. of the cows calved during the best time of the year. This figure was doubled during 1938-39 and is mainly responsible for the large increased production from 193 lbs. to 217 lbs. per cow.

The results achieved in the Dardanup Unit this year with 768 cows is gratifying, and it is hoped that this Unit will continue to increase its production until at least an average of 250 lbs. butter fat per cow has been achieved.

The Capel and Dardanup Units—two large Units which embrace respectively 679 and 760 cows—are Units which are seriously affected by seasonal conditions, particularly the Capel Unit.

By careful farm management a high percentage of the cows in these Units calved early in the season, and some of the farmers with the largest herds do not conserve fodder for feeding to their dairy cows, as these farmers dry off their herds early in the new year, turning the animals on to dry feed which has been reserved for this purpose until near calving. It is probable that higher productions could be obtained by lengthening the lactation period by hand-feeding, but this may be unprofitable with such large herds if the labour involved in the cutting of fodder reserves is high. This aspect of fodder conservation has not been investigated fully, although for small and medium sized herds there is little doubt that the practice of fodder conservation is extremely profitable.

Optimum Lactation Period.

As in previous years an analysis of the dates of calving of the 8,892 cows which have completed test during the year has been made with a view to correlating the time of calving with the production of cows, and the results of such analysis corroborate those for previous years; and as, since the inception of the scheme in 1933-34, approximately 50,000 cows have been under test, the information may be considered reliable.

Ensuring high autumn production by ample fodder reserves for summer and early autumn feeding. Mr J. Littlefair's farm, Pemberton

In the graph below it will be noticed that peak production was given by those cows calving between the end of March, April and May, with a slight reduction for cows which calved during June. Where cows calved after July, the fall in average production was rapid, the lowest production being where cows calved towards the end of September, October, and November.

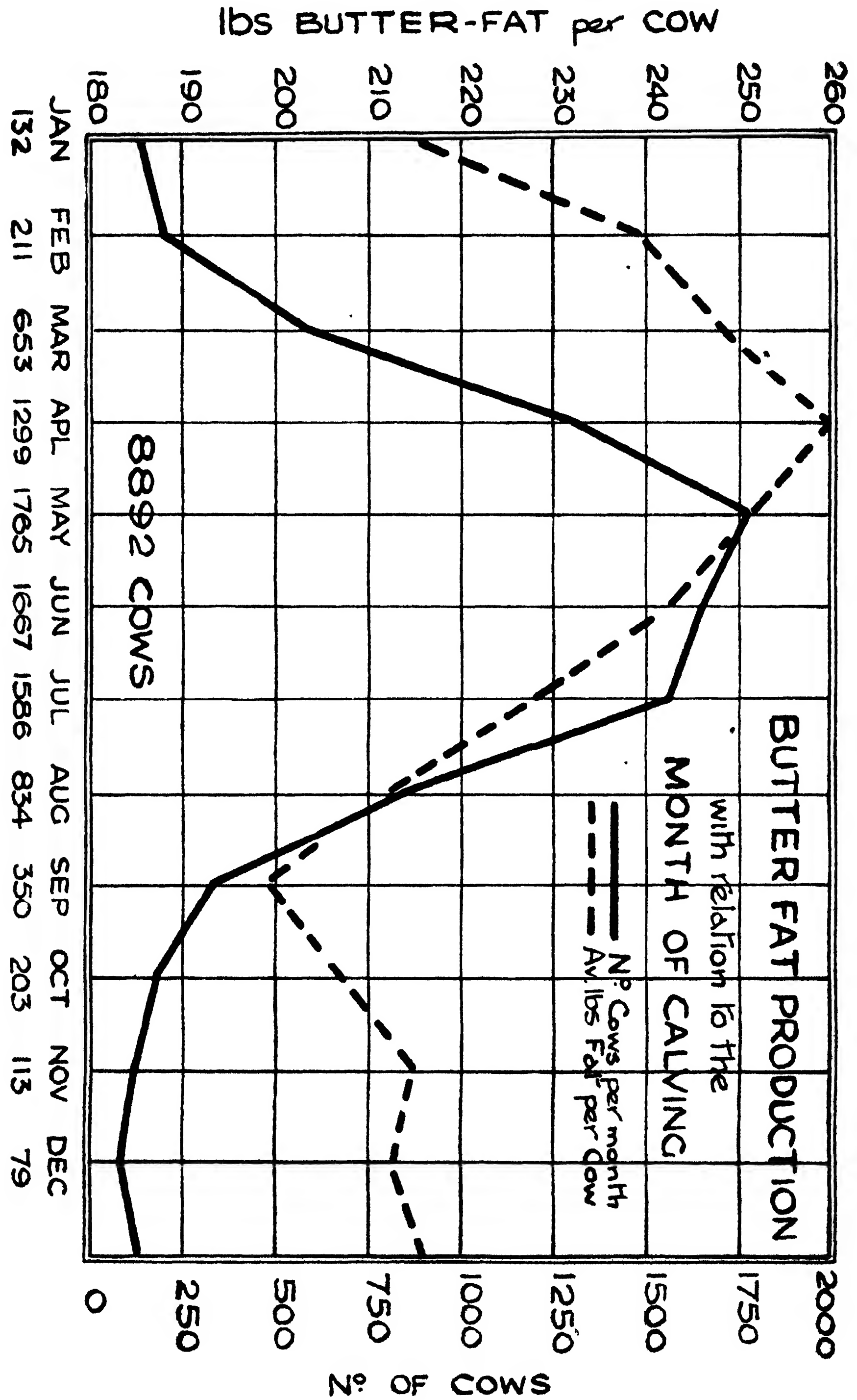
Authorities on conditions necessary for economical dairy production have stated that dairy farming can only be profitable where there is a season of at least 10 months growing period for pasture and, for this reason, it was considered doubtful if the South-West portion of Western Australia could be called dairying country. By reason, however, of developing a special system applicable to local conditions, dairy farmers are able to produce butter fat at prices comparable with those in other portions of the Commonwealth.

Two of the main practices which have been developed are—

(1) An endeavour to commence all lactations as early in autumn as possible, with the view of enabling the cows to have green pasture for a long period—approaching nine months.

(2) An ample conservation of fodder so that cows may be kept in high condition prior to the commencement of the next lactation.

These two factors combined with the generally recognised policy now of improving production along sound breeding lines has placed dairy farming on a sound footing in Western Australia.


lbs BUTTER-FAT per COW
180 190 200 210 220 230 240 250 260
JAN FEB MAR APL MAY JUN JUL AUG SEP OCT NOV DEC
132 211 653 1299 1765 1667 1586 834 350 203 113 79
8892 COWS
BUTTER FAT PRODUCTION
with relation to the
MONTH OF CALVING
Nº Cows per month
Av. lbs Fat per Cow
0 250 500 750 1000 1250 1500 1750 2000
Nº OF COWS

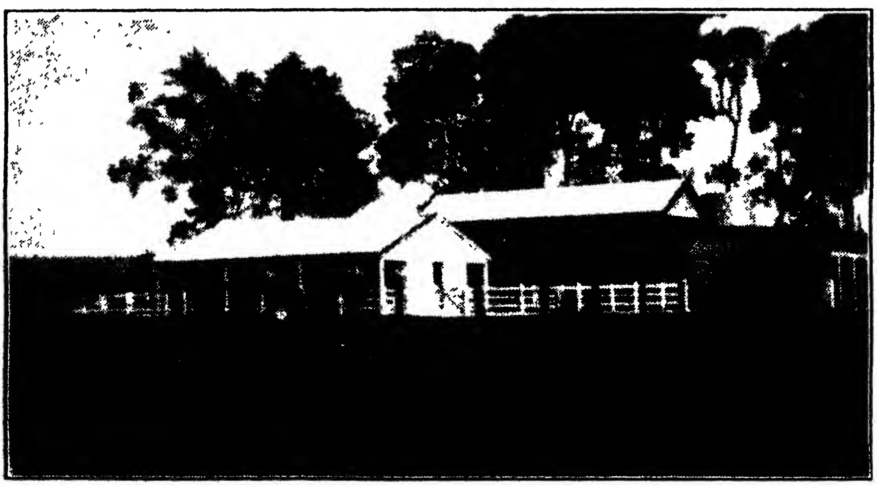
In Table 5 is shown the percentage of cows which commenced their lactation prior to July of last year, and also a comparison of the production of these cows with the average produced by all the cows in the Unit.

TABLE 5.

PERCENTAGE OF COWS COMPLETING 9 MONTHS TEST.

Unit.	Cows.	Butter Fat.	Unit Average Butter Fat.
	%	lbs.	lbs.
A. Donnybrook	86	236 54	230·10
B. Serpentine	85	250·39	236·90
C. Cookernup	74	273·31	252·05
D. Harvey	49	262·28	244·42
E. Brunswick	63	293·80	284 37
F. Dardanup	58	222·95	216·94
G. Capel	78	233·75	222·18
H. Balingup	87	264·35	262·10
I. Forest Grove	57	260·82	240 58
J. Pemberton	69	273 61	244·76
K. Rosa Brook	50	252·44	221·57
L. Vasse	63	184 60	171 91
M. Manjimup	78	219·95	209·19
O. Benger	95	235·57	233 67
P. Coolup-Pinjarra	78	235·66	218·20
Q. Greenbushes	39	269·19	222 19
S. Albany	68	216 41	196 83
T. Bridgetown	99	184·05	184·76
U. Metricup	71	281 65	250 36
V. Ruabon	53	221 55	188 97
W. Northcliffe	36	209·73	180 89
X. Cowaramup	43	276 32	195·45
Y. Narrogin	67	180·46	164 04

It is significant that the new Units generally, except that at Bridgetown, do not approach the average high percentage of cows calving in the early autumn as in those Units which have been in the scheme for a number of years.



Mr. J. Salerian's dairy at Hamel. Cows are fed in the bails in the left foreground, and pass into the milking bails through a concrete race. Hay shed holds approximately 100 tons of hay. Herd of 78 cows averaged 290 lbs. of butter fat.

Of particular interest are the results in the Dardanup Unit which, during 1937-38, only had 29 per cent. of the cows calving during the desirable portion of the year, part of which was due to outbreaks of disease causing partial sterility in the district and which is being overcome. During the following year the percentage of cows was double, namely 58 per cent., which calved during the early autumn and the average production of the Unit has increased from 193 lbs. to 217 lbs. per cow.

Herds Grouped According to Production.

In Table 6 below an indication of the general uplift which is occurring in the production of herds which have been tested for a number of years is clearly shown.

TABLE 6.

HERDS GROUPED ACCORDING TO PRODUCTION.

Year.	Butter Fat per Head (lbs.).							
	Over 400.	350–400.	300–350.	250–300.	200–250.	150–200.	100–150.	Under 100.
	%	%	%	%	%	%	%	%
1933–34 ...	...	..	1·31	3·93	20·30	53·55	18·30	2·61
1937–38 ...	·26	·77	4·07	19·34	45·29	26·46	3·55	·26
1938–39 ...	...	·40	7·40	23·30	37·50	25·20	5·80	·40

It will be noted that whereas in the first year of testing in 1933-34 nearly three-quarters of the herds under test yielded an average production of less than 200 lbs. butter fat per cow, by 1938-39 these low producing herds had been reduced to approximately 30 per cent. which, however, is still in excess of what may be regarded as satisfactory.

One of the reasons why there is still approximately one-third of the herds in the scheme with an average production of less than 200 lbs. butter fat is that a number of farmers test their herds for one year only, or possibly two years, and then withdraw from the scheme for 12 months, the argument being that—as all cows in the herd have been tested—there is no further information to be gained by testing the same cows again.

It is worth mentioning, however, that those farmers who have remained in the scheme since the inception, or who do not withdraw their herds for short periods, are those who having attained a high average production are maintaining that high level.

During last year also six new Units commenced operation and many herds in these new Units are in the low producing groups. It is hoped that these unprofitable herds will ultimately be reduced to a very low percentage.

The table shows clearly that there is a general tendency for the number of herds in the higher production groups—over 250 lbs. butter fat per cow—to be increased and that in the 250 to 300 lbs. group the percentage of herds has increased nearly sixfold and by a similar proportion in the 300-350 lbs. group since the inception of the scheme five years ago.

Cows Grouped According to Production.

In the following Table 7 the production of cows in the two aged groups of Mature and Junior cows, being those which were under three years of age at time of calving, are given according to production.

TABLE 7.

COWS GROUPED ACCORDING TO AGE AND PRODUCTION.
(All cows tested less than 90 days excluded.)

Age Class.	Groups according to Butter Fat Production (lbs.).								Total Cows.
	Over 600.	500 600.	400-500.	300-400.	200-300.	150-200.	100-150.	Less than 100.	
	%	%	%	%	%	%	%	%	
Mature	·02	·2	1·6	17·3	45·4	20·0	11·4	4·1	10,439
Junior*	...	...	·26	4·9	34·1	28·1	22·4	10·2	1,929

* Cows under 3 years at date of calving.

As would be expected, the actual production of junior cows is less than that of mature cows, and, after making due allowance for production according to age, it is found that there is approximately the same percentage of mature cows and junior cows which failed to attain 200 lbs. butter fat during their lactation period.

During the initial years of the scheme it was noted that the production of heifers, after making due allowance for age, was considerably in excess of the average production of mature cows, which indicated that the breeding policy of farmers generally, namely, the use of a pure bred bull of one breed consistently was bearing fruit.

As would be expected, however, as the average production of herds increased, there has been an increasing difficulty amongst farmers to obtain sires with a sufficiently high "butter fat backing" as to improve and even maintain the higher herd averages. This was reflected last year in the fact mentioned above that approximately the same percentage of heifers and mature cows failed to reach the minimum economic production of 200 lbs. butter fat.

During the two previous years it was noted that the percentage of heifers in herds was unusually high, being as high as 25 per cent. to 34 per cent. which tended to reduce the general average of production.

Taking the average working life of a cow as six years, the normal percentage of heifers need not exceed 17 per cent. or one heifer for every six milking cows to maintain the herd at full strength.

It is interesting to notice that, during the year 1938-39, the percentage of heifers in herds is now 16 per cent., which should mean high average production in the ensuing year should the season be normal.

Herds Grouped According to Production.

The following four tables, Nos. 8 to 11, which give the productions of leading herds grouped according to their size, yield interesting information regarding

what can be effected by adopting those methods which have proved practical and efficient in dairy husbandry.

In Table 8 are shown those herds in order of merit which produced over 295 lbs. butter fat and consist of less than 20 cows. Seventeen herds during 1938-39 produced more than 300 lbs. butter fat per cow compared with only four herds two years previously.

TABLE 8.

HIGH PRODUCING HERDS OF LESS THAN 20 COWS.

Owner.	Unit.	No. of Cows.	Breed.	Butter Fat Average.
				lb.
R. L. Maidment	Capel	11	Shorthorn ...	362·50
L. Temple	Harvey	13	Jersey	345·12
O. Foan	Donnybrook	19	do.	336·81
T. Twaddle	Cookernup	17	do.	328·52
A. Clifford & Sons ...	Donnybrook	16	do.	328·35
Mrs. L. R Barnsby ...	Pemberton ...	19	Guernsey ...	327·49
W. J. Burt	Cowaramup . . .	18	Jersey	321·60
H. G. Letchford (sen.) ...	Greenbushes	15	do.	311·17
J. McEwin	Cookernup	13	do.	311·07
J. Poller	Brunswick	17	do.	305·35
D. Della	Pemberton . . .	13	Guernsey . .	305·10
F. George	Rosa Brook	16	Jersey	305·04
R. R. Graham	Pemberton	13	Shorthorn ...	303·76
J. Sibson	Metricup	14	Jersey	303·74
H. L. Newman	Albany	19	do.	303·29
W. Watson	Bridgetown ...	16	do.	302·16
Proctor & Langley ...	Donnybrook	16	do.	301·26
R. Cooper	Metricup	13	Guernsey ...	297·88
M. Brennan	Balingup	19	Jersey	297·01
D. Bendotti	Pemberton . .	17	Guernsey ...	294·87

The following Table 9 shows an even greater improvement in the number of herds with from 20 to 40 cows exceeding 290 lbs. butter fat per cow. During 1938-39, 17 herds of this size produced over 300 lbs. butter fat per cow, whilst two years previously only five exceeded this figure.

A herd in this group which has maintained production at a high level for a number of years is that of Mr. A. Tomerini, Balingup, which during 1937-38 averaged 308 lbs. butter fat from 32 cows and, in the next year, increased this average production to 350 lbs. butter fat from 34 cows.

It is instructive to notice that throughout the herd recording scheme those herds which are achieving the highest production and maintaining the level are those which are either pure bred cows or are cows which have been bred consistently to the same breed with carefully selected bulls and are in appearance and may be regarded genetically as of reasonably pure blood.

This is the policy advocated in all those countries where the high production per cow is of importance in the dairying industry, and it is believed that the nearer the herd approaches any one pure breed of the dairy types the higher will be the average production, and that with a crossbred herd, although high production may be obtained for one or two years, there is extreme difficulty and quite an element of luck in maintaining that high yield.

TABLE 9.

HIGH PRODUCING HERDS OF 20–40 COWS.

Owner.	Unit.	No. of Cows.	Breed.	Butter Fat Average.
				lb.
A. Tomerini	Balingup	34	Jersey	352·15
S. Bowers	Brunswick	31	do.	351·10
L. A. House	Pinjarra	20	do.	339·20
C. P. House	Capel	30	Shorthorn ...	337·80
A. Miller	Cowaramup	24	Jersey	332·17
A. F. Clifton & Co. ...	Brunswick	26	do.	326·66
R. Hutchinson	do.	25	do.	323·29
R. A. Clarke	do.	38	do.	321·84
G. B. Omodei	Pemberton	24	Guernsey ...	319·96
J. Hartley	Brunswick	29	Jersey	317·79
W. Blaikie	Cowaramup	25	do.	315·44
Ellis Bros.	Brunswick	34	Shorthorn ...	311·95
L. Westcott	Serpentine	21	do.	307·56
W. J. Sears	Donnybrook	25	Jersey	307·49
F. G. Williams	Pinjarra	27	Jersey x Friesian	306·83
Mrs. H. K. Ellis	Balingup	29	Jersey	306·57
A. M. Brazier	do.	30	Shorthorn ...	301·40
L. C. Williams	Cookernup	30	do.	299·10
C. Gilmour	Dardanup	31	Jersey	293·25
Bell Bros.	Brunswick	23	Friesian	289·35

The following Table 10 gives a list of those herds of from 41 to 60 cows producing more than 257 lbs. butter fat per cow. During 1937-38 no herds in this group produced over 300 lbs. butter fat per cow and only seven herds exceeded 250 lbs., whereas, during the year 1938-39 just completed, three herds produced over 300 lbs. butter fat and ten produced over 257 lbs. butter fat per cow.

TABLE 10.

HIGH PRODUCING HERDS OF 41–60 COWS.

Owner.	Unit.	No. of Cows.	Breed.	Butter Fat Average.
				lbs.
S. C. Maidment	Balingup	41	Jersey	332·55
Mrs. D. B. Rose	Brunswick	50	do.	317·75
D. Scott	Balingup	57	do.	311·26
T. Jamieson	Capel	52	Shorthorn ...	294·85
A. S. Warburton	Brunswick	49	do.	294·22
T. Stanley	Benger	43	do.	279·10
G. Dempster	do.	59	do.	276·79
K. H. Clifton	Dardanup	44	Jersey x Guernsey	267·83
W. Noakes	Brunswick	42	Shorthorn ...	262·80
G. E. White	Balingup	52	Jersey	257·41

In large herds, particularly those being conducted on commercial lines, it is difficult to attain and maintain high average yields.

The production of the herd owned by Mrs. D. B. Rose in the Brunswick Unit is instructive as showing the results which may be obtained by the consistent use

of information supplied from the scheme and also the value of testing each year, although average productions may appear satisfactory.

The following figures indicate the increase in production during the four years that this herd has been under test:—

Year.	No. of Cows.	Average Butter Fat.	Total Butter Fat.
		lbs.	lbs.
1935-36	70	185·1	12,957
1936-37	62	210·8	13,072
1937-38	51	293·9	14,991
1938-39	50	317·8	15,890

It will be seen that the average butter fat production of the herd has been raised by approximately 78 per cent. during these four years, and that during last year—when 20 less cows were being milked—the total butter fat produced was 2,933 lbs. valued at £183 in excess of that given during the first year of testing.

The herd owned by Mr. S. C. Maidment, Balingup, also deserves special notice, as this herd was increased from 29 to 41 cows between the year 1937-38 and 1938-39, while at the same time the average production was increased from 313 lbs. to 332 lbs. butter fat per cow.

The following Table 11 shows the production of herds with more than 60 cows which exceeded 240 lbs. butter fat per cow.

The leading herd—that of Messrs. Lieper and Dempster—with 62 cows has only been under test for one year with the high average production of 333 lbs. butter fat per cow. It is believed that only by continuous testing can this high average production be maintained, particularly as the herd has been increased in number rapidly by means of purchased cows.

The herd owned by Mr. J. Salerian is an example of increasing and maintaining production by careful management and breeding. This herd was increased from 66 to 78 cows in 1938-39, while at the same time the average production was increased from 266 to 290 lbs. butter fat per cow. This herd while containing only a few pure bred Jerseys is being consistently "graded up" with Jersey bulls of high "butter fat backing," and, because of the uniformity of type of the cows in the herd and the policy of breeding, these high production yields may be maintained.

TABLE 11.

HIGH PRODUCING HERDS OF OVER 60 COWS.

Owner.	Unit.	No. of Cows.	Breed.	Butter Fat Average.
				lbs.
Leiper & Dempster ...	Metricup	62	Jersey	333·20
J. Salerian	Cookernup	78	do.	289·55
P. Fitzpatrick	do.	69	Shorthorn ...	280·38
Mrs. U. Eastcott	do.	64	Jersey	245·21
J. Neil	do.	78	Shorthorn ...	242·72

Each year a list of 20 leading cows in the scheme is published in the form shown in Table 12 below, and the average production of these cows shows a progressive rise each year.

This is the first year during which the production of an individual cow has exceeded 700 lbs. of butter fat for the lactation period, while two cows have exceeded 600 lbs. butter fat, 10 cows have exceeded 500 lbs. butter fat, and only three cows produced less than 400 lbs. butter fat per cow.

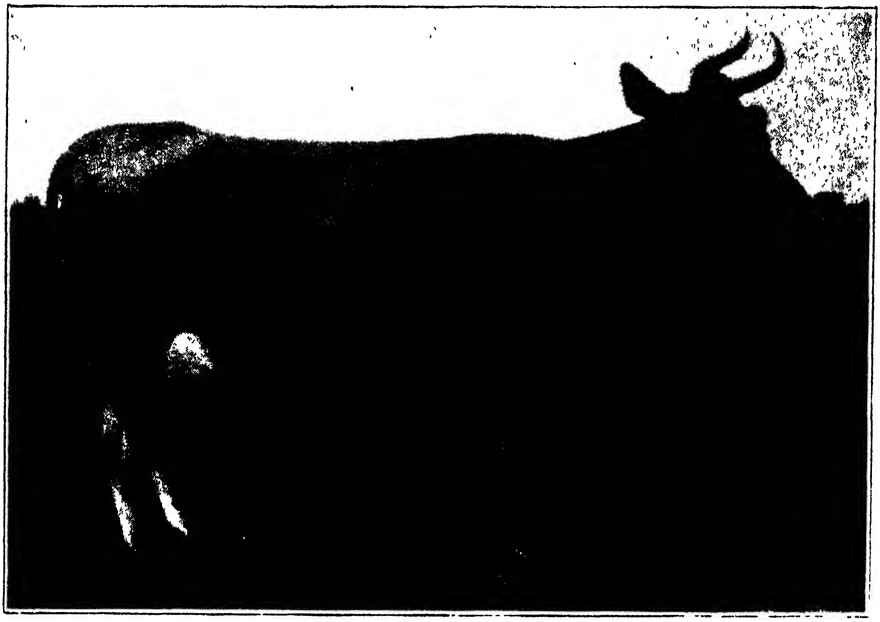
The yields of the Jersey cow "Belle" owned by Mr. C. Piggott, Brunswick, are outstanding. In 1937-38 this cow produced 641 lbs. butter fat during the year, and calved normally in 1938-39 and produced 705 lbs. butter fat. It is interesting to note that this cow is a pure bred Jersey bred on the estate of the late P. Rose, Balingup, but was sold as a cow culled for type and without a pedigree to Mr. Piggott at the ruling rate for grade cows.

TABLE 12.

HIGHEST PRODUCING COW IN EACH UNIT.

Owner.	Unit.	Name of Cow.	Tattoo.	Breed.	Test.	Butter Fat.
					%	lbs.
C. Piggott	Brunswick	Belle ...	EQ 1	Jersey ...	5·06	705·00
T. Jamieson	Capel ...	Moana ..	GS 59	Shorthorn x Jersey	5·83	688·95
F. Byrd	Harvey ..	Chrissie ...	DT 518	Friesian x	4·52	671·96
W. Darnell	Rosa Brook	Dolly ..	IC 14	Guernsey ...	4·88	550·05
D. Della	Pemberton	Tiger ...	JN 5	Guernsey x Jersey	5·20	545·67
O. Foan	Donnybrook	Poppy ..	AL 20	Jersey ..	5·55	540·39
G. H. Dixon	Bridgetown	Daisy ...	TK 17	do. .	5·34	534·41
L. C. Winduss ...	Cookernup	Jossie ...	CB 6	Shorthorn x Jersey	5·27	534·03
L. A. House	Pinjarra ...	Nigger ...	PL 17	Jersey x Shorthorn	4·80	511·26
Lieper & Dempster ...	Metricup ...	Bonnie ...	US 6	Shorthorn ...	5·04	500·09
A. Tomerini	Balingup ...	White Tail	HJ 24	Jersey ...	5·84	481·33
A. Miller	Cowaramup	Babs ...	KM 10	do. ...	5·20	462·13
W. Blair	Forest Grove	Betty ...	IL 14	Guernsey ...	4·90	460·51
Misses E. & I. Rutherford	Albany ...	Biddy ...	SD 4	Jersey x Ayrshire	4·19	441·56
T. B. Stanley ...	Benger ...	Polly ...	OM 9	Shorthorn ...	4·50	441·44
C. Gilmour	Dardanup	Seven ...	FE 7	Jersey ...	4·65	438·12
L. Westcott	Serpentine	Maggie ...	BG 15	Shorthorn x	4·85	434·62
H. G. Letchford (sen.)	Greenbushes	Pokey ...	QX 10	Jersey ...	4·90	433·75
S. Sansom	Ruabon ...	Lily ...	O☒S 12	Shorthorn ...	4·03	410·38
W. Leo	Manjimup	Queenie...	ML 14	Guernsey x	4·20	403·90
Narrogin School of Agriculture	Narrogin ...	Cloud ...	YD 6	Ayrshire ...	4·68	375·57
F. Oliver	Northcliffe	Creamy ...	W— 4	Guernsey ...	4·29	368·76
L. Johnston	Vasse ...	Daisy ...	LC 11	Jersey ..	5·84	334·24

The "Sunny-West" Cup presented by the South-West Co-operative Dairy Farmers, Ltd., to the owner of the four highest producing cows in any herd tested under the grade herd recording scheme has been won for the third year in succession by Mr. T. Jamieson, of Capel.



"Seven" Tattoo F E 7 Highest producing cow in the Dardanup unit, 438 lbs of butter fat in 9 months Owned by Mr C. Gilmour

The records of Mr. Jamieson's four cows are as follows:—

	Lbs. Butter Fat.
Moana	688 95
Magpie	562 5
Felix	531·69
Betty 2nd	508 35
Average	572 87

The only cow in this group which was in the winning *four* last year was "Betty 2nd" which produced 541 lbs. butter fat during 1937-38.

The three leading cows were purchased by Mr. Jamieson amongst a number of stock which previously had been intended for the butcher but, owing to being near to calving, were passed into the dairy herd and proved to be the highest producing cows in that herd.

"Proved" Bulls.

Following the practice which was commenced in 1936-37, a further list of "proved" pure bred bulls having six or more daughters that have been tested and have produced over 200 lbs. butter fat has been compiled and is given below in Table 13.

During the previous two years the names of 90 bulls and the average production of their daughters, together with the names of the owners of these bulls where such are known, were published and the present list contains the names of a further 55 "proved" sires.

In view of the comparative scarcity of these "proved" bulls, it is hoped that all daughters of these sires, which are from cows testing over 250 lbs. butter fat and, therefore, are eligible for identification under the Calf Marking Scheme, will be marked and registered.

TABLE 13.

BULLS WITH SIX OR MORE DAUGHTERS WHICH HAVE PRODUCED NOT LESS THAN 200 LBS. BUTTER FAT.

Name of Sire.	No. Daughters Tested.	Butter Fat.	Owner's Name.	Unit.	
		Average lbs.			
Guernsey—					
Koojan Golden Dividend	13	386	G. Omedei ...	Pemberton	Dead
Rosendale Prince ...	7	323	Mrs. L. R. Barnsby	do.	
Wollongbar Mandate ...	8	273	do. do.	do.	Dead
Minnamurra Aladdin ...	8	236	J. Jay	Northcliffe	Killed
Woolumbin Eastern King	11	235	J. Downes ...	do.	do.
Woolumbin Pastor ...	6	255	J. Jay	do.	do.
Nundorah Cloud Sovereign	8	235	G. Jackson ...	do.	Dead
Australian Illawarra Shorthorn—					
Wooroloo Bobs ...	7	305	Late R. R. Graham	Pemberton	
Hill View First Hope . .	13	281	P. Fitzpatrick ...	Cookernup	
Tipperary Camelia's Re-Echo	23	255	W. Palmer ...	do.	
Glan Avon Percy ...	11	201	Mrs. L. Faulkner & Sons	Albany	
Telyarup Renown . .	14	231	J. J. Daly ...	do.	
Telyarup Major ...	11	212	A. W. Collins ..	Coolup	
Minathorpe Bruce 4th .	28	237	Kingsley Fairbridge Farm	Pinjarra	
Gentle Signal of Sarnia	33	229	do. do.	do.	
Jersey—					
Grassvale Broken Duke	15	291	E. W. Dilkes ...	Catterick-Greenbushes	Dead
Moorland's Digger ...	17	295	H. Williams .	do.	10 yrs.
Noble Fondant ...	16	297	F. Heywood ..	do.	Dead
Juadine Gay Lad ...	15	260	do. .	do.	do.
Masterpiece of Landscape Hill	12	270	O. L. Myers ...	Forest Grove	
Melrose Spiriter . .	12	248	Now unknown ...	do.	
Maxon's Starbright Prince	9	321	do. ...	do.	
Sabina Vale Airio ...	13	279	A. & A. E. Millar	do.	
King's Vale Banner ...	7	304	Now unknown . .	do.	
Aghyl Dere Bonnie Prince	6	233	J. H. Oldfield ..	do.	
Capel's Noble	20	269	Now unknown ...	do.	
Eurach Red-cloud ...	20	273	W. J. Rowe ...	do.	
Nooka King Twilish ...	8	285	S. West	do.	
Mokine Jock	9	269	G. Davis	do.	
Grass Vale Fowler's Twilish	31	306	J. Salerian ...	Cookernup	
Melrose Sultan	6	290	G. Scott	Boyanup	
Mokine Hero	6	324	F. Richards ...	Dardanup	
Mokine Mystery ...	6	207	W. Atkins ...	do.	
Compaanile's Duke of Grass Vale	6	266	G. H. Brett ...	do.	
Noble Fowler of Grass Vale	10	322	E. M. Rose ...	Serpentine	
Grass Vale Twylish ...	6	246	do. ...	do.	
Mokine Apollo	23	220	A. Thorne ...	Rosa Brook	
Rosecliffe Noble Lord ...	6	286	R. Hayward ...	do.	
Roseworthy Majestic ...	7 .	281	J. A. Nilsson ...	do.	
Karrawarra Graceful Willie	16	227	do.	do.	Dead

TABLE 13—*continued*.

Name of Sire.	No. Daughters Tested.	Butter Fat.	Owner's Name.	Unit.
		Average lbs.		
Jersey—*continued*.				
Colmyn Winkle ...	7	247	J. M. Nelson ...	Vasse
Nairn Ellisford	6	216	W. Packard ...	do.
Garden Hill Sportsman	9	224	Gorton & Gumprich	Coolup
Moorland's Dago ...	20	260	O. F. H. Bowles ...	do.
Travalgan Air Chief ...	27	237	W. M. Smith ...	do.
Greenmount Gay Lord	11	270	J. Davidson ...	do.
Colmyn Prince George ...	8	250	D. Morris ...	Ruabon
Colmyn Rye Prince ...	6	251	L. Wetherley ...	do.
Ayrshire—				
Tipperary Moonlight ...	6	299	W. P. Harris ...	Dardanup
Creamery Prince ...	6	291	T. P. Harris ...	do.
Ferndale Blueboy ...	13	264	R. H. Briggs ...	Serpentine
Friesian—				
Chittering Patrick Korndyke	10	277	Geo. Betts ...	Serpentine
Dunmore Duncan ...	10	255	do.	do.
Dunmore Ivanhoe ...	18	316	W. Taylor ...	do.
Red Poll—				
Aberbechan George ...	6	246	C. Flynn	Dardanup

Average Production of all Units.

Particulars of the production of the herds in all Units which were under test during 1938-39 are appended hereunder.

Donnybrook "A."	No. of Cows.	Butter-fat Average.	Serpentine "B."	No. of Cows.	Butter-fat Average.
		lbs.			lbs.
O. Foan ("L")	19	336·81	L. Westcott ("G") ...	21	307·56
A. Clifford & Sons ("G*")	16	328·35	F. E. Jackman ("R")...	25	280·86
W. J. Sears ("A") ...	25	307·49	G. Scott ("U") ...	15	270·42
Herd F*	16	301·26	Herd H	19	267·21
" C	14	285·28	" V	25	245·20
" RA	9	272·19	" O	28	242·11
" RD	14	267·03	" T	20	238·97
" H	25	265·11	" M	15	237·88
" L*	18	247·18	" A	65	235·72
" P*	8	244·97	" S	26	220·51
" F	32	235·14	" L	8	218·41
" RX	27	231·26	" N	11	208·32
" E	21	229·99	" X	13	206·25
" C	10	227·60	" E	15	202·26
" RJ*	11	226·63	" C	13	190·47
" E	44	221·03	" D	16	137·24
" X	31	220·23			
" C*	21	217·48			
" D	39	216·51			
" —A	27	214·23			
" RK	11	209·16			
" —B	40	205·11			
" RY	11	199·06			
" RF*	34	194·93			
" A*	26	183·86			
" RP	12	183·19			
" K	30	182·10			
" RR	12	178·66			
" RJ	21	170·32			

* Letter reversed.

Cookernup "C."	No. of Cows.	Butter-fat Average.	Harvey "D."	No. of Cows.	Butter-fat Average.
		lbs.			lbs.
T. Twaddle ("J*") ...	17	328·52	L. Temple ("C") ...	13	345·12
J. McEwin ("Y") ...	13	311·07	Mrs. A. G. Eckersley ("E")	23	284·10
L. C. Winduss ("B") ...	30	299·10	E. Holthouse ("AC") ...	18	278·62
Herd CS ...	78	289·55	Herd AN ...	15	274·35
" 9C ...	69	280·38	" A ...	35	273·09
" R* ...	11	279·71	" T ...	33	268·55
" L ...	30	273·24	" NM ...	16	267·59
" 6C ...	36	270·66	" ND ...	22	264·90
" E* ...	25	269·76	" P ...	32	259·23
" P ...	22	259·82	" B ...	25	255·07
" 4C ...	35	252·64	" NB ...	15	249·53
" A ...	9	252·16	" B* ...	43	241·59
" J ...	23	248·24	" NH ...	24	233·22
" Y* ...	64	245·21	" U ...	21	228·76
" 7C ...	78	242·72	" L† ...	28	221·17
" F* ...	28	219·97	" AD ...	26	208·84
" T ...	26	218·56	" G ...	39	204·68
" 2C ...	16	216·57	" NR ...	27	204·22
" F ...	69	215·88	" AG ...	14	203·40
" D ...	30	213·58	" C*† ...	20	183·64
" V ...	41	170·48			

* Letter reversed † Tested 7 months only.

Brunswick "E."	No. of Cows.	Butter-fat Average.	Dardanup "F."	No. of Cows.	Butter-fat Average.
		lbs.			lbs.
S. Bowers ("F") ...	31	351·10	C. Gilmour ("E") ...	31	293·25
A. F. Clifton & Co. ("Q")	26	326·66	A. Wicksteed ("W") ...	14	269·80
R. Hutchinson ("R*")...	25	323·29	F. Richards ("I") ...	15	269·29
Herd C* ...	38	321·84	Herd N ...	44	267·83
" M* ...	29	317·79	" C ...	28	253·63
" B* ...	50	317·75	" S ...	19	250·85
" B ...	34	311·95	" AE ...	18	249·56
" T* ...	17	305·35	" A ...	39	241·09
" O ...	49	294·22	" A*Q ...	16	240·33
" P* ...	23	289·35	" A*N ...	22	235·65
" A* ...	24	284·19	" A*E ...	60	234·52
" D ...	14	274·57	" A*L ...	66	232·65
" E ...	33	268·37	" D ...	69	219·44
" Q* ...	18	266·88	" A*D* ...	43	213·22
" A ...	42	262·80	" D* ...	26	211·16
" U ...	33	262·33	" M ...	28	204·90
" K* ...	30	256·77	" A*M ...	37	203·28
" X ...	37	255·20	" C* ...	12	201·41
" H ...	25	254·06	" K ...	49	195·38
" L* ...	37	232·52	" AI ...	51	193·11
" U* ...	39	210·18	" A*K ...	32	186·45
			" A*M* ...	24	162·23
			" A*B* ...	22	161·56
			" A*C* ...	38	133·93

* Letter reversed.

Capel "G."	No. of Cows.	Butter-fat Average.	Balingup "H."	No. of Cows.	Butter-fat Average.
		lbs.			lbs.
R. L. Maidment ("W")	11	362·50	A. Tomerini ("J") ...	34	352·15
C. P. House ("D") ...	30	337·80	S. C. Maidment ("S") ..	41	332·55
T. Jamieson ("S") ...	52	294·85	D. Scott ("K") ...	57	311·26
Herd F	33	273·72	Herd N	29	306·57
„ I	40	272·11	„ A*	30	301·40
„ N	32	237·50	„ R	19	297·01
„ M	35	229·99	„ V	32	280·21
„ C	24	211·95	„ Z	35	276·38
„ A	77	209·88	„ U	38	269·90
„ K	38	208·88	„ Q	11	269·72
„ B	42	208·42	„ B*	26*	264·71
„ Z	65	207·71	„ D*	15	261·81
„ O	13	201·47	„ C	52	257·41
„ P	9	177·24	„ K*	42	254·44
„ J	39	176·61	„ F*	44	254·07
„ U	28	172·97	„ C*	28	247·66
„ R	40	169·08	„ Y	20	245·11
„ V	71	161·90	„ E	36	238·28
			„ D	24	230·50
			„ L	31	228·62
			„ H4	20	217·84
			„ P	29	217·70
			„ HS	35	216·06
			„ G*	45	204·94
			„ J*	31	171·46

* Letter reversed.

Forest Grove "I."	No. of Cows.	Butter-fat Average.	Pemberton "J."	No. of Cows.	Butter-fat Average.
		lbs.			lbs.
H. Eddy ("U") ...	20	288·36	Mrs. L. R. Barnsby ("B")	19	327·49
P. O'Farrell ("7") ...	19	281·17	G. B. Omodei ("O") ...	24	319·96
T. Kitson ("V") ...	14	277·50	D. Della ("N") ...	13	305·10
Herd F*	32	274·71	Herd G	13	303·76
„ Z	21	265·43	„ U	17	294·87
„ D	42	255·02	„ A	16	258·41
„ L	20	253·47	„ AB	10	251·97
„ C	17	246·50	„ C	13	251·54
„ T*	36	243·44	„ Q	16	243·47
„ D*	17	238·37	„ F	12	241·43
„ P	16	237·37	„ R	21	240·96
„ T	17	237·29	„ L	18	240·85
„ K	17	231·66	„ P	12	233·84
„ Q	29	230·27	„ H	12	230·94
„ J*	26	228·60	„ V	15	224·63
„ B*	16	223·65	„ T	7	203·90
„ K*	19	214·57	„ Y	14	185·87
„ E*	25	211·55	„ X	7	185·57
„ V*	20	202·40	„ Z	20	182·44
„ G*	12	186·40	„ I	29	168·26
„ W	13	183·45			
„ AB	4	124·87			

* Letter reversed.

Rosa Brook "K."	No. of Cows.	Butter-fat Average.	Vasse "L."	No. of Cows.	Butter-fat Average.
		lbs.			lbs.
F. George ("Q") ...	16	305·04	D. H. Bell ("Z") ...	15	261·01
W. Darnell ("U") ...	11	291·09	L. Johnston ("C") ...	27	247·42
D. P. Smith ("E") ...	18	283·39	R. J. Seymour ("P*")	24	227·29
Herd T*	15	282·57	Herd A*	14	201·38
" A*	17	275·05	" H	23	189·32
" A	34	272·36	" T	37	183·70
" Y*	21	269·92	" V	13	182·49
" Z	18	251·95	" D*	21	179·30
" P	17	236·54	" N*	40	175·92
" D	30	232·56	" K*	11	169·17
" B*	30	227·17	" W	34	168·72
" W	19	225·14	" Y	24	168·19
" S	18	218·89	" J*	13	165·07
" R	14	217·97	" S*	26	161·03
" E*	26	216·95	" M*	26	153·19
" H	33	214·57	" B*	23	139·54
" G*	28	212·80	" G*	15	133·09
" B	25	208·38	" O	75	118·58
" J*	14	202·01			
" R*	32	199·15			
" C	25	197·38			
" X	24	186·57			
" F	29	182·80			
" G	26	157·04			
" D*	35	133·64			

* Letter inverted. * Letter "lazy."

Manjimup "M."	No. of Cows.	Butter-fat Average.	Benger "O."	No. of Cows.	Butter-fat Average.
		lbs.			lbs.
W. Hamilton ("N") ...	13	273·27	J. Fimmel ("Y") ..	13	284·50
W. J. Morgan ("I") ...	13	271·74	T. Stanley ("M") ...	43	279·10
H. Brown ("Q") ...	17	270·58	W. Barnes ("G") ...	35	277·43
Herd L	15	259·01	Herd E	59	276·79
" C	25	258·67	" J	35	270·21
" B	22	245·91	" D	20	254·38
" B*	19	245·66	" F*	47	244·20
" A	53	233·71	" L	36	231·14
" D	18	229·45	" AA	14	228·38
" E	23	226·24	" C	15	223·30
" V	11	218·88	" Z	36	218·19
" J	12	210·25	" T	24	207·78
" Z	35	208·31	" V	24	205·11
" X	23	205·82	" X	16	203·23
" E*	26	197·51	" AE	12	202·56
" F	27	197·05	" B	31	201·22
" K	17	195·97	" AJ	21	187·75
" T	18	195·64	" S	18	182·38
" U	19	191·28	" P	42	177·63
" S	31	189·65			
" C*	16	183·99			
" R	30	181·06			
" Y	47	180·00			
" G	26	172·45			
" W	25	141·49			

* Letter reversed. * Letter inverted.

Pinjarra "P."	No. of Cows.	Butter-fat Average.	Greenbushes "Q."	No. of Cows.	Butter-fat Average.
		lbs.			lbs.
L. A. House ("L") ...	20	339·20	H. G. Letchford, sen. ("X")	15	311·17
F. G. Williams ("M") ...	27	306·83	T. Giblett ("P*") ...	11	285·64
J. Davidson ("A*") ...	33	288·93	F. Capon ("V*") ...	20	274·92
Herd J	26	279·56	Herd I	22	271·89
" B	28	265·82	" J	18	270·46
" U	22	260·51	" J*	15	264·19
" B*	11	244·72	" H	30	263·69
" F	19	240·77	" V	28	256·74
" A	37	231·39	" P	26	248·06
" Y	43	226·52	" Y*	15	247·26
" AB	12	224·18	" B	20	244·27
" N	22	223·25	" C	42	228·45
" V	10	221·20	" L‖	19	215·35
" K	26	192·83	" Y	25	196·49
" D	22	191·54	" F	15	196·14
" G	28	188·04	" K	10	187·29
" C	29	181·66	" Z‡	61	186·09
" I	36	167·84	" K*‡	30	169·71
" T	84	147·98	" O‖	17	166·64
" W	16	122·30	" T*	22	159·90
			" A*‡	20	158·95
			" B§	21	156·77

* Letter reversed.

* Letter inverted. ‡ Tested 6 months only.
§ Tested 7 months only. ‖ Tested 8 months only.

Albany "S."	No. of Cows.	Butter-fat Average.	Bridgetown "T."	No. of Cows.	Butter-fat Average.
		lbs.			lbs.
H. L. Newman ("B") ...	19	303·29	W. Watson ("C") ...	16	302·16
A Bracknell ("A*") ...	16	265·57	G. Henderson ("H") ...	22	285·78
Misses Rutherford ("D")	5	262·05	G. H. Dixon ("K") ...	27	271·25
Herd K*	16	255·84	Herd A	45	247·16
" L	23	244·46	" Q	37	229·50
" Q*	18	224·85	" B	21	220·15
" F	10	219·51	" J	26	213·68
" J	15	218·07	" R	22	192·36
" I	20	217·99	" D	40	183·38
" X	22	216·14	" W	29	175·79
" Y	17	193·10	" S	20	173·50
" E	21	187·70	" E	38	172·72
" V*	28	186·05	" N	36	169·28
" R	14	180·91	" G	29	167·23
" G*	14	180·74	" O	32	161·21
" P*	35	179·12	" Z	16	160·18
" B*	17	171·91	" F	24	158·79
" U*	20	169·55	" L	59	151·29
" A	27	163·03	" V	16	149·01
" C*	27	156·18	" U	46	129·16
" T	31	114·21	" M	38	128·39
			" P	18	102·62

* Letter reversed.

Metricup "U."	No. of Cows.	Butter-fat Average.
		lbs.
Messrs. Leiper and Dempster ("S")	62	333·20
J. Sibson ("T") ..	14	303·74
R. Cooper ("I") ...	13	297·88
Herd V	7	286·94
,, B	24	267·69
,, Q	32	266·18
,, O	16	263·02
,, H	21	254·56
,, W	19	253·93
,, L	24	252·80
,, D	24	242·59
,, P	23	234·43
,, E	24	234 13
,, N	35	232·34
,, M . .	24	228·08
,, G .. .	18	224·09
,, C . . .	22	213·49
,, J .	24	212·91
,, F . ..	11	212·56
,, A . .	22	190·56
,, K ..	20	187·66
,, R .. .	11	176·80

Ruabon "V."	No. of Cows.	Butter-fat Average.
		lbs.
A. Teates ("W") ...	24	236·73
H. Billinghurst ("H") ...	30	236·00
S. Sansom ("P") ...	17	230·90
Herd N	35	228·55
,, M	24	224·20
,, K	30	220·01
,, X	46	215·30
,, O	28	214·17
,, R	26	199·99
,, D	9	197·90
,, L	24	190·64
,, S	39	187·35
,, Y	17	177·17
,, F . .	33	165·26
,, Z	24	162·54
,, E	23	156·83
,, G	33	151·07
,, A .. .	24	149·02
,, T	41	137·26
,, B	37	134·67

Northcliffe "W."	No. of Cows.	Butter-fat Average.
		lbs.
G. Willis ("H") ...	19	247 85
H. Heathcote ("X") ...	19	231·19
J. Moran ("F") ...	23	219·27
Herd L	15	218·96
,, J .	26	215·18
,, B	21	211 82
,, C . ..	28	207·57
,, M	19	199·35
,, K .. .	25	190·75
,, D	24	188·93
,, I*§	15	186·73
,, T	14	184·32
,, Z	16	184·20
,, O	18	182·98
,, G	36	181·96
,, U	46	181·80
,, E	20	170·55
,, P	24	165·04
,, S	25	162·21
,, R	20	159·26
,, V¶	11	159·19
,, Y‖	22	142·16
,, A	40	123·29
,, N‡	11	99·76
,, I†	15	88·32

Cowaramup "X"	No. of Cows.	Butter-fat Average.
		lbs.
A. Miller ("KM") ...	24	332·17
W. J. Burt ("H") ..	18	321·60
W. Blaikie ("A") ...	25	315·44
Herd KL . .	20	284·32
,, I	24	270·35
,, N . .	13	252·71
,, KI	20	250·29
,, T	24	230·22
,, B	21	220·81
,, G .	17	217·47
,, F . ..	31	216·68
,, KJ	27	215·05
,, D	30	192·20
,, C	28	191 14
,, L	31	180·38
,, Y	33	173·71
,, J	24	159·60
,, X	18	159·29
,, KY	14	149·14

* Letter "lazy." † Tested 3 months only. ‡ Tested 5 months only.
§ Tested 6 months only. ‖ Tested 7 months only. ¶ Tested 9 months only.

Narrogin "Y."	No. of Cows.	Butter-fat Average.	Narrogin "Y"—*contd.*	No. of Cows.	Butter-fat Average.
		lbs.			lbs.
D. Bradford ("H") ..	15	248·15	Herd A	45	146·45
Narrogin School of Agriculture ("D") ...	13	229·79	" B	88	146·18
			" G	14	142·85
E. Booth ("E") ...	17	225·75	" J	16	138·56
Herd F	13	211·26	" K	14	133·30
" I	12	205·35	" L	14	110·43
" C	10	188·50	" M	11	103·68

Plant Hormones and their Practical Importance in Horticulture.

By H. L. PEARSE, Ph.D., A.R.C.S., D.I.C.

Technical Communication No. 12 of the Imperial Bureau of Horticulture and Plantation Crops, East Malling, Kent, England, 1939. Price 3s. 6d. stg.

A recent aid to the horticulturist is the discovery of plant hormones, or auxins, which have been found to promote root development on cuttings and may be used successfully to improve the results of the plant propagator in the nursery. Dr. Pearse has described the practical application of this discovery in this small book, which has been compiled especially for the practical horticulturist.

During the last decade, the importance of growth promoting substances within the plant has been amply demonstrated. These substances, known as plant hormones or auxins, are produced in one part of the plant, generally the developing terminal buds and young leaves, and move to other parts where they stimulate growth activities. Of the growth activities, root production in cuttings is of paramount importance to the nurseryman and horticulturist.

It is true that the great German scientist, Sachs, in 1865 postulated the existence of substances which governed the growth processes of plants, but for nearly 70 years their identity defied discovery and their mode of action remained obscure. In 1933, three of these substances were discovered and their chemical composition determined. They were called auxins or plant hormones, and are considered by many plant physiologists to be indispensable for the growth of plants.

Dr. Pearse has devoted his attention largely to the practical application of the scientific discoveries and theories with respect to auxins or plant hormones to horticultural problems. Perhaps vegetative propagation is one of the most important of horticultural practices and any process which will facilitate the rooting of cuttings will be welcomed by horticulturists.

Research has shown that appropriate use of auxins will increase root formation and shorten the time required for roots to form with species which are easy or only moderately difficult to root. With those difficult to root, however, a response is frequently not so readily obtained and success is dependent on the selection of the most suitable material—condition of the wood, health of parent plant, appropriate care of the cuttings, the use of accessory substances such as the vitamin thiamin, etc. It is evident that each plant must be studied individually in order to determine the most suitable technique and appropriate auxin treatment to obtain the best results. In this connection, Dr. Pearse has tabulated for the benefit of propagators the published experience with respect to about 350 species of plants.

Since the discovery of the three natural auxins a number of other substances have been added to the list of substances effective as plant hormones. Extensive investigation has shown that three compounds, which may be prepared in the laboratory and are available in pure crystalline form from chemical firms, may be mentioned as particularly effective in promoting root formation. These are—

(1) -naphthalene-acetic acid,
(2) indolyl-butyric acid,
(3) indolyl-acetic acid.

They may be used—

(1) as a dip in which the base of the cutting is immersed for a number of hours,
(2) as a dust applied to the base of the cutting,
(3) as a paste when dissolved in lanoline,
(4) as a solution with which the cuttings are watered.

Of these, the first method seems most effective in practice.

On account of their very great physiological activity, auxins must be used in great dilution—0.001 per cent. to 0.02 per cent.: higher concentrations may be very injurious.

A wealth of detail is given in Dr. Pearse's paper and the attention of the reader desiring further information is directed to over 200 references used in the preparation of the text.

—L. J. H. TEAKLE.

Agricultural Problems.

Agriculturists, pastoralists and primary producers generally, who may be having difficulties of any kind in connection with their production activities, are invited to communicate with the Agricultural Adviser of their district of the Department of Agriculture, when information and advice will be supplied free of charge.

Where identification of plant or stock diseases or insect pests is required, full details of symptoms should be forwarded and also samples of the diseased plant, animal tissue or insect where practicable. Plant tissue intended for examination by the Plant Pathologist should be wrapped in paper and not forwarded in airtight containers, and plant specimens for the Botanist should be pressed between newspaper

and dried before despatch. With regard to animal tissue for microscopic examination, this should be forwarded in a solution of 10 per cent. formalin, or if of considerable bulk in a sealed kerosene tin containing a few ounces of formalin as a preservative. Living insects should be sent in suitable containers and dead specimens in methylated spirits.

The addresses and names of Advisers are as follows:—

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